

Schizotypy, theory of mind and the understanding of irony

Ben Barnaby

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University College London

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Overview

This thesis aims to investigate C. Frith's (1992) cognitive neuropsychological model of schizophrenia by using the schizotypy paradigm to test the model's predictions in a non-clinical sample. The thesis is divided into three parts.

Part 1 begins with a summary of the notion of Theory of Mind (ToM), the ability to infer one's own and others' mental states. Its main theoretical conceptualisations are discussed, as well as a range of ToM measures, and how ToM has been linked to Autistic Spectrum Disorder. Next, Frith's model is described, followed by the predictions made by the model. The evidence that has been generated through past empirical studies is then reviewed and methodological weaknesses in these studies discussed. Finally, the schizotypy paradigm is introduced and details of previous studies that have used it to test the predictions of Frith's theory are given.

Part 2 presents the empirical paper, an investigation into whether ToM ability is associated with those schizotypal traits hypothesised to be analogous to symptoms of schizophrenia. This was done through the administering of ToM tasks requiring the understanding of double bluff, deception, white lies and irony. The results of the study are reported and discussed in the light of the predictions made by Frith's (1992) model.

Part 3 provides an opportunity for further reflection on several points of interest arising from Parts 1 and 2, in the form of a critical appraisal.

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Part 1: Review paper

1. Abstract

Frith's (1992) cognitive neuropsychological model of schizophrenia proposed that the symptoms characteristic of that disorder can be accounted for in terms of differing degrees of theory of mind impairment. There is a large body of evidence indicating that individuals with schizophrenia perform poorly on tasks that are hypothesised to require a functioning theory of mind, and this review aims to introduce the main findings from these studies.

Following consideration of thirty-four relevant papers, this review finds that the only unequivocal finding is that individuals with schizophrenia do show impaired theory of mind. How this impairment relates to schizophrenic symptomatology as predicted by Frith's model is far less certain, and several methodological limitations are discussed that could account for this uncertainty, before a new development in the field is introduced: the use of the schizotypy paradigm to test the predictions of Frith's theory in non-clinical samples. The schizotypy paradigm has been employed in three studies investigating ToM performance in healthy individuals to date (Langdon and Coltheart, 1999; Langdon and Coltheart, 2004; Pickup, 2006), and the findings from these studies show that schizotypal traits do influence ToM performance. These studies are reviewed, and future directions for research are recommended.

2. Introduction

This paper reviews the research evidence for a possible link between Theory of Mind (ToM) deficits and the impairments associated with a diagnosis of schizophrenia, with a view to exploring a recent development in the investigation of schizophrenia- the use of the schizotypy paradigm.

Chris Frith (1987; 1992) first put forward a coherent theory postulating such a link, and since its publication a substantial body of research has been developed in this area. A detailed review of this research base in its entirety is beyond the scope of this paper. Therefore, while the main findings from the wider literature are reported to provide the appropriate context, the focus here is the literature concerning impairments of the interpretation of indirect speech in individuals with schizophrenia.

Firstly, a brief outline of the theoretical underpinnings to the research base is provided, before the main findings from the literature are outlined. Then, important methodological issues in the literature are considered, before a more detailed exploration of indirect speech interpretation and schizophrenia is undertaken. This is followed by a summary of the new developments in the area of schizotypy, and how this concept has been utilised in schizophrenia research, in particular research into ToM impairments in schizophrenia. Suggestions for further research are then given.

Formal systematic review methodology such as devising a focused, four part review question involving patients, interventions, comparisons and outcomes, having two reviewers screening titles and abstracts and reading full-text articles, computing inter-

rater reliability and carrying out statistical analyses of studies' data (Pai et al., 2004) was beyond the scope of this paper.

Papers for this review were identified through searches of Medline and PsychInfo, using search terms including “theory of mind and schizophrenia/schizotypy”, “mentalising and schizophrenia/schizotypy”, “metarepresentation and schizophrenia/schizotypy”, and through other recently published reviews of the literature.

3. Theory of Mind

3.1 Background

The term ‘theory of mind’ (ToM) was first used by Premack and Woodruff (1978) during their work with chimpanzees, and involves both the recognition that people act on the basis of mental states, i.e. beliefs, desires etc, and the attribution of these states to oneself and others in order to explain and predict behaviours. There are, therefore, different aspects to this mental-state inferring process. These have been described using various terminologies. For example, ‘metarepresentation’ has been defined by Frith (1992) as the internal, mental representation of ourselves and others as conscious beings who mentally represent external reality. Langdon and Coltheart (1999) defined the ability to infer states of mind, in other words to use ToM, as ‘mentalising’, a term first used by U. Frith, Morton and Leslie (1991) in their study of children with autism. Mentalising would be impossible without the ability to engage in metarepresentation, so these are terms that describe different aspects of the ToM process.

It has been argued from an evolutionary perspective that ToM may have emerged as an adaptive response to living in an increasingly complex social world. This greater degree of sociality may have been an advantage for individuals in terms of increased protection from predators but a difficulty could have been how to behave in such a way that reproductive success was maximised. From an evolutionary perspective, the need to pass on one’s genes through reproduction is of paramount importance. Individuals who are able to represent others’ states of mind, and in this way ‘read’ others’ minds, may be able to operate in this complex social environment with a greater degree of mastery, thus leading to greater social and, therefore, reproductive success (Brüne, 2005a). This

greater mastery could be due to either an improved capacity for “social grooming” (Dunbar, 1996) or the detection of intentional deception by peers (Byrne, 2003).

3.2 Theoretical underpinnings

There are several different theoretical conceptualisations of ToM. Scholl and Leslie (1999) proposed the existence of a ToM module (ToMM), following Fodor’s (1983) concept of a modular organisation of the mind. In their theory, the ToMM processes information that is restricted to social inference. Scholl and Leslie (1999) argued that the accurate functioning of the module depends on a selection processor to separate relevant from irrelevant contextual information.

By contrast, Perner (1991) put forward the “metarepresentational” theory-theory. This non-modular model suggested that different levels of representational skill are acquired in steps during normal child development. The first step is the acquisition of primary representations of the self as an acting agent. Secondary representation allows for the discrimination of hypothetical from real situations. In other words, a theory is employed to make attributions of mental states of others. Within Perner’s model, an individual’s understanding of their mind is a framework or a theory analogous to scientific theories (Gopnik and Wellman, 1994).

The third theoretical framework is the “simulation” theory. This theory proposed that ToM relates to the ability to imaginatively “put oneself in others’ shoes” (Davies and Stone, 1995). In this theory, an individual’s ability to attribute their own mental states in a given scenario is used to simulate what another person may be thinking in a similar

situation. Gordon (1995) proposed that the brain actually begins to function like the other's brain by generating similar processes in the self. The recent discovery of 'mirror neurons', which fire both when an action is carried out by an individual and when that individual observes the same action being carried out by another (Rizzolatti, Fadiga, Gallese & Fogassi, 1996), may lend weight to this theory.

3.3 Measuring theory of mind

The 'gold standard' test of comprehending other people's minds is the ability to show the understanding that others can hold false beliefs that are different from one's own correct knowledge (Dennett, 1978). The classic test, developed by Wimmer and Perner (1983), is called the Sally and Anne Test. In this test, one character, Anne, hides an object while a second character, Sally, is out of the room. The person being tested has to decide whether Sally would look for the object in the place that she knew it was in before she left, or would look in the place that Anne had hidden it. In other words, the individual must be able to distinguish between their own correct knowledge and Sally's false knowledge. This is a first order false belief test, as it requires the ability to "metarepresent" Sally's mental state, i.e. to understand that "Sally thinks that...".

Other tests of ToM involve the understanding of higher order false belief tasks, metaphor, irony and faux pas. A second order false belief test would explore an understanding of what a character thinks about a different character's thoughts, for example, "Michael thinks that Sophie thinks that...". The understanding of irony is said to involve second order ToM because the listener must go beyond the literal meaning of the words used by the speaker and infer what the speaker might have actually intended

(Brüne, 2005a). Similarly, metaphor, jokes, faux pas and so on all involve the ability to infer a meaning that is not explicit in the actual words used, and all have been used as tests of ToM ability.

3.4 Clinical application in autism

ToM has been most extensively researched in the area of Autistic Spectrum Disorder (ASD). An absence of ToM is widely held to be responsible for the triad of impairments that are seen in people with ASD, identified by Lorna Wing (1979): impairments in social interaction, communication and imagination. Uta Frith (1989) proposed that a lack of the mechanism that allows humans to have a ToM could explain the triad. For example, if a child is unable to infer the mental states of others, they will be unable to engage in pretend or imaginative play. Without a ToM the child's communication will be different from other children's because the child would not be able to take into account the beliefs, intentions or mood of the person to whom they are speaking. This inability to take beliefs and so on into account will also severely damage the child's ability to interact in the social world leading to 'autistic aloneness' and a lack of social interaction (U. Frith, 1989).

3.5 Autistic Spectrum Disorder and Schizophrenia

In their 1991 chapter, Frith and Frith pointed out that although there are clear differences between ASD and schizophrenia, for example the presence of hallucinations and delusions in schizophrenia but not in ASD, some striking similarities are also present. They considered that the negative symptoms of schizophrenia (e.g. social withdrawal, lack of communication, lack of spontaneous, creative behaviour and increased

stereotyped activity) mapped very closely to the triad of impairments identified by Wing (1979), and could be seen as a distinctive cluster of social, communicative and imaginative impairments. They further suggested that ToM impairments may also account for these difficulties, in the same way that ToM difficulties could account for Wing's triad of impairments.

C. Frith (1992) developed this observation into a theory of schizophrenia that aimed to account for schizophrenic symptomatology in terms of an impairment of ToM. I will give an outline of his model in the following section, before discussing the research evidence that has accumulated following its publication.

3.6 Summary

This section gave an outline of the current thought on ToM, the ability to understand one's own and others' mental states, a skill that is hypothesised to be crucial to successfully negotiating the complex human social environment. Methods used to measure ToM were described, as was the concept of different 'orders' of ToM. Deficits in this skill have been theorised to underpin the impairments seen in Autistic Spectrum Disorder, and a link between ASD and schizophrenia was highlighted. The next section will report how Frith used this observation to develop his model of schizophrenia.

4. Frith's (1992) cognitive neuropsychological model of schizophrenia

4.1 Symptom classification

There have been many attempts to classify the symptoms of schizophrenia since Kraepelin (1896) and, later, Bleuler (1911) described the condition. One influential classification has been that of Crow (1980), who divided schizophrenic symptoms into 'positive' and 'negative'. Positive symptoms were defined as being abnormal by their presence, such as hallucinations and delusions, while negative symptoms were defined by the abnormality of absence of particular behaviours. These would include flat affect and poverty of speech or action. After Crow, Liddle (1987) carried out factor analyses of symptoms and found three factors. The first he called 'psychomotor poverty', which included poverty of speech, flattening of affect and motor retardation and is similar to Crow's negative subtype. The second factor, 'reality distortion' (delusions and hallucinations), and third, 'disorganisation' (incoherence and incongruity) were divisions of Crow's positive subtype.

Within Frith's (1992) theoretical framework, a distinction is made between the bizarre experiences and beliefs that a person with schizophrenia can describe ('symptoms') and the behavioural abnormalities that can be observed ('signs'). Therefore, signs can be defined as behaviours associated with schizophrenia, and symptoms can be defined as experiences associated with schizophrenia. Frith divided the 'signs' of schizophrenia into those which are positive and negative, using the same definition of positive and negative used by Crow (1980). The negative signs are thus concerned with the lack of a behaviour, for example poverty of action or speech, flattening of affect or social withdrawal, while the positive signs include incoherence of speech or incongruity of

affect. In Frith's model, the positive symptoms of schizophrenia described by Crow (1980), i.e. hallucinations and delusions, were labelled 'symptoms'. These were largely unobservable events experienced by individuals with schizophrenia and described by them to others.

4.2 The model

Frith (1992) proposed that there were three principal abnormalities in schizophrenia which could account for all of the signs and symptoms. These abnormalities were: disorders of willed action, disorders of self-monitoring and disorders of monitoring the intentions of others.

4.2.1 Disorders of willed action

Frith noted that behavioural signs seemed to occur specifically in situations in which patients had to generate the required actions for themselves. In other words, these patients may have a particular difficulty with actions that are self-initiated, while having little difficulty with those actions that are carried out in response to environmental stimuli. He proposed that three types of specific abnormality could be accounted for as a consequence of an impairment of 'willed action'. Firstly, poverty of action or speech might occur if a person was unable to generate a spontaneous response and so did nothing. Second, perseverative or stereotyped behaviour might result if a person who was unable to generate a spontaneous response repeated their previous response. Thirdly, a person who was unable to generate a spontaneous response may respond inappropriately to an irrelevant stimulus in the environment, causing stimulus-driven behaviour (Frith, 1987; 1992).

4.2.2 Disorders of self-monitoring

Frith (1992) proposed that some of the positive symptoms of schizophrenia, for example some delusions and auditory hallucinations, could be interpreted as resulting from a defect of self-monitoring. In the absence of an awareness of their own intentions, patients may experience their actions and thoughts as not being their own, and instead being under someone else's control, for example in the case of delusions of control or thought insertion.

Auditory hallucinations, according to Frith's model, can be thought of in a similar way. Patients would perceive their own thoughts or sub-vocal speech as emanating from a source that is not under their control, rather than recognising them as their own intentional speech acts. Therefore, according to Frith (1987), patients with positive symptoms can still act spontaneously on the basis of willed intentions, but they are no longer aware of these intentions.

4.2.3 Disorders in monitoring the intentions of others

Paranoid delusions and delusions of reference both occur, according to the model, as a result of incorrect inferences that the patient has made about the intentions of other people. Patients with paranoid delusions incorrectly think that other people are trying to harm them, while those with delusions of reference think that others are trying to communicate with them or are talking about them. Further, a defect in the monitoring of others' intentions could lead to the behavioural sign of incoherent speech if the patient is unable to decide what information the other person needs in order to understand them (Frith, 1992).

4.3 Frith's model and theory of mind

In his model, Frith attempted to tie together the three cognitive mechanisms described above into one unified theory of schizophrenia, which would identify a single underlying cognitive deficit that could describe all of the features of schizophrenia. He identified ToM as being one such possible deficit.

Frith created an account of how a malfunctioning ToM could account for the signs and symptoms of schizophrenia. In line with his model, he outlined three relevant areas in which ToM, or metarepresentation, plays a key role. These areas were awareness of one's own goals, awareness of one's own intentions and awareness of other people's intentions, and Frith theorised that these areas corresponded to the three types of cognitive impairment outlined above that his model suggested were the underlying cause of the signs and symptoms of schizophrenia. Specifically, without awareness of one's own goals, disorders of willed action would be caused; without awareness of one's intentions, disorders of self-monitoring occur; and without an awareness of the intentions of others, delusions of persecution and of reference can occur.

Frith (1992) noted that autistic spectrum disorder and schizophrenia, although similar in some ways, differ in an important respect. This is that ASD is usually present from birth, whereas schizophrenia typically occurs in a person's twenties or thirties. This means that in ASD the whole course of development may be shaped by the inability to infer mental states. However, in schizophrenia, the person knows that others have mental states and has experienced a working ToM during development, but then may have lost that ability at the onset of illness. They will still have, however, the ritual and behavioural routines

for interacting with people that do not require any mental state inferences to be made. This developmental difference could lead to the same underlying defect manifesting itself in different ways. In particular, a person with ASD may not try to infer the mental states of others, while an individual with schizophrenia may continue to make inferences about others, but may often get these wrong (Frith, 1992).

4.4 Predictions of the model

One particular advantage of Frith's model was that it led to a set of specific predictions that could be tested experimentally using tasks that require an understanding of others' minds. According to the model, individuals who exhibited predominantly behavioural signs, either negative or positive, were hypothesised to suffer from severe and widespread mentalising deficits, and so should score very poorly on ToM tasks. Individuals with paranoid symptoms, such as persecutory delusions, and with no behavioural signs, were thought of within the model to have largely intact, but malfunctioning, ToM skills, leading to impaired performance on ToM tasks, but not as poor as that exhibited by those with behavioural signs. Individuals with passivity experiences (e.g. thought insertion, delusions of control) were predicted to show no ToM deficits on tests of the understanding of others' minds, as were those in remission at the time of testing.

4.5 Summary

In this section, Frith's model was presented. Firstly, his method of grouping the symptomatology of schizophrenia into behavioural signs and symptoms was outlined. Secondly, his model of schizophrenia and how it related to ToM impairments was detailed. Specifically, a lack of awareness of one's own goals could lead to disorders of willed action, causing behavioural signs; a lack of awareness of one's intentions leads to disorders of self-monitoring, causing some auditory hallucinations and delusions; and lack of awareness of the intentions of others lead to delusions of persecution and reference. The model's predictions with respect to performance on ToM tasks were then described.

In the next section, the state of the current literature will be outlined.

5. State of the current literature

The interest generated by Frith's (1992) model led to a large number of studies being published. Two recent reviews have examined these in some depth (Brüne, 2005a; Harrington, Siebert & McClure, 2005). A brief sketch of the main findings in the literature will be given here, before several key methodological issues are discussed.

5.1 Outline of the main findings

Appendix 1 gives details of all of the studies investigating ToM deficits in schizophrenia reviewed for this paper. Across all of these studies, there has been the consistent finding that, as predicted by Frith (1992), ToM deficits are indeed associated with a diagnosis of schizophrenia. Many of these studies made use of tests to estimate general intelligence, memory, or executive function, and found that when the difficulties that individuals with schizophrenia have in these areas are controlled for, their ToM deficit remained. As well as controlling for other neuropsychological impairments, many of the studies compared the performance of participants with schizophrenia with the performance of individuals with other psychiatric diagnoses, finding in all cases that those with schizophrenia performed more poorly than the psychiatric controls. There is strong evidence, therefore, that the ToM deficit seen in schizophrenia is not accounted for by other neuropsychological deficits or psychiatric illnesses.

With respect to the specific predictions made in Frith's (1992) model, the results have been far more equivocal. Individuals with behavioural signs have performed consistently more poorly than controls across several studies. This is the case for both positive behavioural signs such as thought disorder or disorganised symptoms (Doody, Götz,

Johnstone, Frith & Cunningham Owens, 1998; Grieg, Bryson & Bell, 2004; Sarfati and Hardy-Baylé, 1999; Sarfati, Hardy-Baylé, Besche & Widlöcher, 1997; Sarfati, Hardy-Baylé, Brunet & Widlöcher, 1999; Sarfati, Hardy-Baylé, Nadel, Chevalier & Widlöcher, 1997) and negative behavioural signs (Corcoran, Cahill & Frith, 1997; Corcoran, Mercer & Frith, 1995; Frith and Corcoran, 1996; Langdon et al., 1997; Mitchley, Barber, Gray, Brooks & Livingston, 1998). The picture for individuals with paranoid symptoms is more mixed, however. Several studies (Corcoran et al., 1995; 1997; Corcoran & Frith, 1996; Frith & Corcoran, 1996; Marjoram et al., 2005; Pickup & Frith, 2001) have shown that patients with paranoia or persecutory delusions do show ToM deficits, while others have been unable to show such a link (Grieg et al., 2004; Langdon, Coltheart, Ward & Catts, 2001; Mazza, De Risio, Surian, Roncone & Casacchia, 2001; Walston, Blennerhassett & Charlton, 2000).

Studies that investigated patients in remission found a similarly mixed picture. While several showed no difference between a remitted group and controls (Corcoran et al., 1995; 1997; Frith & Corcoran, 1996) other studies showed that patients in remission performed at the same level as patients with schizophrenia (Randall, Corcoran, Day & Bentall, 2003), and that those in remission performed more poorly than their relatives, who also performed more poorly than healthy controls (Janssen, Krabbendam, Jolles, & van Os, 2003). This finding has since been challenged by Kelemen, Kéri, Must, Benedek and Janka (2004), who used the Eyes test in their study comparing relatives of individuals with schizophrenia to controls. Using this test, they found no difference between relatives' performance and the performance of controls. These mixed results

from relatives and those in remission have led to increased debate about whether ToM deficits in individuals with schizophrenia constitute a state or trait deficit.

Lastly, for those patients with passivity experiences, several studies have shown a lack of ToM deficit, in line with Frith's model (Corcoran et al., 1995; Frith & Corcoran, 1996), and this appears to be a consistent finding in the literature.

In light of these findings, it is clear that the current state of the literature is characterised by conflicting results, with different studies reporting contradictory findings on the relationship between symptomatology and ToM in schizophrenia. In the following section, this review will investigate some methodological factors that may have contributed to these mixed findings.

5.2 Methodological issues in evidence base

There are several issues in the literature investigating ToM deficits in schizophrenia that require further consideration. Firstly, the different ways in which studies have grouped participants with schizophrenia for comparison, secondly the different tasks that have been used to test ToM, and thirdly methodological difficulties inherent in carrying out research with individuals with schizophrenia. These three issues will be considered in the following sections.

5.2.1 Schizophrenic subgroups

As outlined above, Frith's (1992) theory made specific predictions concerning ToM deficits depending on the symptoms that individuals present with. Thus, positive and

negative behavioural signs, paranoid symptoms and passivity symptoms are theorised to have different levels of impact on ToM ability.

In view of this, the way participants with schizophrenia are grouped for comparison may have an effect on the results of ToM studies. For example, individuals with passivity symptoms are theorised to have no difficulties with carrying out ToM tasks, while negative behavioural signs such as social withdrawal are theorised to be associated with wide-ranging ToM deficits. Therefore, if participants with social withdrawal are put into a “passivity” group, then their negative symptoms may bias the ToM task result for that group.

The difficulty is that groups of individuals with schizophrenia are extremely heterogeneous, with any one individual potentially exhibiting a wide range of symptoms. Therefore the manner in which samples are sub-divided is crucial when considering ToM task results. The table in appendix 1 shows how the studies reviewed here allocated their participants to groups.

In the first studies in this area, Frith and his colleagues (Corcoran et al., 1995; 1997; Corcoran & Frith, 1996; Frith & Corcoran, 1996) used a hierarchical method of grouping individuals in order to try to address this issue, placing individuals into groups depending on the presence of symptoms according to the predictions of their model. Thus, those participants showing any behavioural signs on the day of testing were placed into one group, those displaying any paranoid symptoms, but no behavioural signs, were placed in another group and those with passivity phenomena, but no paranoid symptoms

or behavioural signs, were placed into a third group. There may also have been a fourth group of individuals who were in remission at the time of testing. While this method prevented individuals who were hypothesised to have severe ToM deficits entering a group hypothesised to have lesser or no ToM deficits, it did leave open the possibility that the behavioural signs group was simply more severely impaired than the other two groups. This is because it was quite possible that members of that group would have behavioural signs, paranoid symptoms and passivity phenomena. If the behavioural signs group exhibited a wider symptom profile, then it is possible that this could have had an impact on their scores on ToM tasks.

Other methods have been used in the literature to form subgroups of individuals with schizophrenia. One such was that favoured by Sarfati and colleagues (Sarfati et al., 1997a; 1997b; 1999; Sarfati & Hardy-Baylé, 1999). Following a theoretical model proposed by Hardy-Baylé (1994, cited by Sarfati et al., 1997a), they divided their samples depending on their scores on the Scale for Thought, Language and Communication Disorders. High scorers were assigned to one group, while those with low scores were assigned to a second group. Sarfati and colleagues described these groups as being high or low in “disorganisation” and drew conclusions based on this distinction. They also administered the Scale for the Assessment of Positive Symptoms (SAPS: Andreasen, 1982) and the Scale for the Assessment of Negative Symptoms (SANS: Andreasen, 1982) (Sarfati et al., 1997b) or the Positive and Negative Symptom Scale (PANSS: Kay, Fisz-Bein & Opler, 1987) (Sarfati et al., 1997a; 1999; Sarfati & Hardy-Baylé, 1999; Sarfati et al., 2000) and found no significant differences between the prevalence of positive and negative symptoms in the two groups. Having found no

significant differences, they concluded that the differences in ToM and other tasks administered across these studies were due to their disorganisation construct. The difficulty with this categorisation was that it took into account only those symptoms that Frith described as positive behavioural signs, while not considering the impact of negative signs or symptoms of paranoia. Although there were no significant differences between the groups in terms of other symptoms, these other symptoms could still have had an effect at an individual level when carrying out ToM tasks, and their influence on group scores cannot be discounted.

Further methods of grouping participants were evident in studies carried out by Langdon and colleagues. For example, Harrington, Langdon, Siegert and McClure (2005) used scores on the SAPS and SANS to divide their sample into 'paranoid' and 'non-paranoid' groups, while Langdon, Coltheart, Ward and Catts (2002) used the same scales to group their participants according to clinical ratings of formal thought disorder. Langdon et al. (1997) and Langdon et al. (2001) administered the SAPS and SANS and used them to allocate their participants according to groups that corresponded to Liddle's (1987) three factors, psychomotor poverty, disorganisation and reality distortion. This methodology was also employed by Mazza et al. (2001). In their paper (Mazza et al., 2001), they published participants' Z scores for each of Liddle's (1987) three dimensions, showing how they allocated individuals to groups. This revealed the extent of the within-group heterogeneity. For example, the reality distortion group contained some individuals with high psychomotor poverty scores, the disorganisation group contained some individuals with high reality distortion scores and so on. It was simply an individual's highest score across the three domains that led to them being allocated to a certain group. This method

therefore carried with it the same difficulty as Sarfati's approach, that it is difficult to say that the ToM scores recorded in, for example, the psychomotor poverty group were not biased by individuals within that group who also scored highly, albeit not as highly, in the other two domains.

Other studies used the PANSS to divide patients according to positive, negative and global symptoms (Doody et al., 1998; Mitchley et al., 1998; Brüne, 2005b) or divided their participants according to the presence or absence of persecutory delusions (Drury, Robinson & Birchwood, 1998). The PANSS was also used by Herold, Tényi, Lénárd and Trixler (2002) in their study of patients with paranoid delusions in remission, although they did not report results based on this subgrouping of individuals, and by Randall et al. (2003) in their investigation of individuals with persecutory delusions. Other studies did not look at subgroups of participants with schizophrenia, preferring to compare groups with and without schizophrenia (Tényi, Herold, Szili & Trixler, 2002).

In summary, studies have used a wide range of methods for allocating participants with schizophrenia to subgroups based on their presenting symptomatology. Due to the heterogeneity of samples of individuals with schizophrenia, each of these methods has limitations in investigating the predictions made by Frith's (1992) model. The methodologies and associated limitations were discussed.

5.2.2 ToM tasks

A second major issue in the literature is the range of different ToM tasks used. Appendix 1 details the kinds of tasks that studies reviewed here used. There are different ways that one could group the tasks for comparison, and this review addresses several of these.

Firstly it is important to consider what the tasks aim to measure, secondly in what format they are designed, and thirdly how they are presented to participants.

Many of the studies reviewed here (19 out of 34, see Appendix 1) used tasks that measured 1st and 2nd order ToM through false belief and deception. Other studies used tasks that aimed to tap into ToM ability in different ways, for example through the use of hints (e.g. Corcoran et al., 1995; Corcoran & Frith, 2003; Grieg et al., 2004; Janssen et al., 2003; Marjoram et al., 2005), jokes (Corcoran et al., 1997; Walston et al., 2000), the understanding of Gricean maxims (Corcoran & Frith, 1996; Tényi et al., 2002), the understanding of the intentions of characters in comic strip cartoons (e.g. Sarfati et al. 1997a; 1997b; 1999) and the understanding of metaphor and irony (e.g. Drury et al., 1998, Herold et al., 2002; Mitchley et al., 1998). What these tasks have in common is that they all require inference, whether it be about a character's beliefs or intentions, or to understand a joke or an ironical statement. It is this inference that is hypothesised to rely upon intact ToM.

When the design of the tasks is considered, a clear distinction arises, namely between verbal and non-verbal tasks. Purely verbal tasks involve only written information being presented to participants. Examples of this type of task include tests of Gricean maxims (Corcoran & Frith, 1996; Tényi et al., 2002), the hinting task (Corcoran et al., 1995;

Corcoran & Frith, 2003) and tests of the understanding of proverbs, metaphor and irony (Brüne & Bodenstein, 2005; Drury et al., 1998; Mitchley et al., 1998). Other tasks can be described as purely non-verbal. These tests use different series of pictures either in card-sorting tasks (e.g. Langdon et al., 1997; 2001; 2002b) or comic-strip tasks (e.g. Sarfati et al., 1997a; 1997b), or make use of computer animation (Russell, Reynaud, Herba, Morris & Corcoran, 2006). A third category of task design mixes verbal and non-verbal tasks. Examples of these types of tasks are Corcoran et al.'s (1997) jokes, or the large numbers of studies that presented false belief tasks in verbal form accompanied by props that depicted the action in the stories, which were read aloud to participants. These props could be in the form of Playmobil figures (Pickup & Frith, 2001), cartoon drawings (e.g. Harrington et al., 2005a; Pollice et al., 2002) or maps and dolls (e.g. Doody et al, 1998).

Lastly, the mode of presentation to participants will be discussed. The way in which tasks are presented is crucial because of the tension that exists between experimental control and ecological validity. As noted above, some tasks involve the presentation of written material to participants (e.g. Corcoran & Frith, 1996). Participants are able to read this information as many times as they wish, and the same applies to many of the tasks involving the presentation of picture cards for sorting (e.g. Brüne, 2005b) and to the comic-strip designs (Sarfati et al., 1997a; 1997b). This methodology aims to minimise the effects of poor memory or executive function skills, but in doing so it also reduces the necessity of participants to rely on “on-line” processing, and allows them the option of using other problem-solving strategies (Pickup & Frith, 2001). The studies that read tasks to their participants with accompanying props were also attempting to control

for poor memory skills, but again they lessened the reliance on participants' on-line skills. However, it is these skills that the tests are targeting, because in the real-life social situations that individuals with schizophrenia find difficult, it is their on-line skills that are being called upon (Russell et al., 2006). One recent study attempted to address these concerns by using a dynamic intentional movement interpretation task (Russell et al., 2006). In this task participants watched the movement of animated triangles and were asked to describe those movements, thus increasing the degree to which the task represented 'real world' processing skills.

There are two reasons that the use of such a wide range of tests is problematic. Firstly, as Harrington et al. (2005b) pointed out, it is highly unlikely that ToM ability is a unitary construct, and that all the different tasks used to assess ability were measuring the same thing. Secondly, the use of these tests has not been accompanied by a rigorous approach to assessing the tests' psychometric properties. Tests have often been selected because of their previous use with children in Autistic Spectrum Disorder research, but there has been no attempt to establish their psychometric properties for use with adult populations (Harrington et al., 2005b).

5.2.3 Difficulties carrying out research with individuals with schizophrenia

As well as the difficulties with the specific methodologies outlined above, there are more general problems to be considered when carrying out research with this population. Firstly, as the table in appendix 1 shows, many of the studies were only able to recruit rather small samples, and the sample sizes became even smaller when individuals were allocated to subgroups for comparison. Small Ns are unlikely to give sufficient power to

carry out statistical analyses and therefore conclusions drawn using such small samples should be considered tentatively. Secondly, as with all studies that recruit participants with current mental health difficulties, a number of confounding factors should be noted. These include the effects of active symptoms and the effects of neuroleptic medication on task concentration and attention. Further, different studies included differing proportions of participants who were inpatients on acute psychiatric wards. They did not, however, specify how many, or more importantly which, participants' results may have been affected by the added emotional stress that inpatient status may bring with it, and whether the results of subgroup analyses may have been biased by these effects.

5.3 Summary

This section has given a brief outline of the major findings in the literature on ToM in schizophrenia. The headline finding has been that people with schizophrenia consistently perform poorly on ToM tasks. Individuals with passivity phenomena have not shown a ToM deficit, and several studies have shown an association between positive and negative behavioural signs and poor performance on ToM tasks in line with Frith's (1992) theory. However, other studies have not and the results for individuals with paranoid symptoms and those in remission have also been conflicting. Several major issues in the literature on schizophrenia and ToM that may have contributed to its ambiguous and rather confusing current state were then highlighted. These issues are the different ways of grouping heterogeneous samples of individuals with schizophrenia, the proliferation of different kinds of ToM tests, and issues inherent in recruiting participants with mental health difficulties. The following section will look at the current evidence in one specific domain of schizophrenia and ToM research which, it will be

argued, may be able to provide some of the best evidence for Frith's (1992) theory: those studies that tested ToM through the use of tests involving the interpretation of indirect speech.

6. Indirect speech

6.1 Background

The previous section highlighted in part the question of the ecological validity of ToM tests. As stated previously, the context of the development of Frith's (1992) theory was the observation of the behavioural similarities between schizophrenia and Autistic Spectrum Disorder. Indeed, the term 'autism' was originally coined to describe the socially cut off nature of people with schizophrenia (Bleuler, 1911). It is the primarily social difficulties that individuals with schizophrenia experience that are so striking.

In view of this, and due to the need for ToM tests to have ecological validity, this review now considers those studies that have investigated the ability of individuals with schizophrenia to appreciate indirect speech. Making the inferences that are necessary to decode indirect speech is a crucial part of normal ('on-line') social interaction. Tests that require such inferences to be made may, therefore, have greater real-world relevance to this group. A very brief history of the field will be given before a more detailed account of the literature is explored.

Pragmatics is the field that studies the ways in which people interpret speech using non-linguistic knowledge and inference that conveys meaning beyond the literal meaning of the words used. Pragmatics can be said to have begun with the work of Grice (1975), who proposed a 'Cooperative principle', and a set of nine maxims that he theorised were assumed in linguistic interactions in order for meaning to be conveyed and understood. Examples of these maxims are the maxim of quantity (i.e. be as informative as required but not more informative than required) and the maxim of quality (i.e. do not say what

you believe to be false, and do not say anything for which you have insufficient evidence). In post-Gricean pragmatics, the work of Sperber and Wilson (1995) and their Communicative Principle of Relevance was important. An explanation of this detailed theory is beyond the scope of this paper, and readers are directed to Sperber and Wilson (1995). Relevant here is that in order for a hearer to understand indirect speech, they must hold in mind the hypothesis that the speaker is capable of entertaining thoughts about, and adopting attitudes towards, the thoughts of other people.

Because of the solid theoretical background to the study of indirect speech, its links with ToM ability (Langdon, Davies & Coltheart, 2002) and the communicative disturbances that are considered to be hallmark features of schizophrenia, indirect speech is an area of study that should lend itself well to researching ToM capabilities in schizophrenia. If this is the case, studies using this methodology should provide some of the best tests of Frith's theory.

6.2 Indirect speech in the literature

Patients with schizophrenia have been known for many years to have difficulties in pragmatic comprehension (Kasanin, 1944, cited in Langdon et al., 2002a). Since researchers began to study ToM deficits in schizophrenia, indirect language comprehension has been used in a variety of studies as a test of ToM ability. This review will group these studies primarily according to the type of test of indirect speech used, but will describe separately those studies that did and those that did not divide their participants with schizophrenia into groups according to their symptoms, because those that did are more directly relevant to an understanding of Frith's theory.

6.2.1 The Hinting Task

6.2.1.1 Studies that investigated symptom-based subgroups

Corcoran et al. (1995) devised a task for their study which tested participants' ability to understand hints. The Hinting task comprised ten short passages that each presented an interaction between two characters, which ended with one of the characters dropping an obvious hint. Participants were asked what the character meant, and were given a second, more obvious hint if they did not answer appropriately. The task was read aloud and repeated if necessary. Corcoran et al. (1995) found that subgroups of patients with negative or paranoid symptoms had difficulties with this task, while those with passivity symptoms or in remission performed at the same level as healthy controls, in line with Frith's (1992) theory.

Grieg et al. (2004) found that performance on the Hinting task was correlated with thought disorder as measured by the SAPS and PANSS. They also reported a significant correlation between ToM performance and the PANSS delusion item, although no correlation was found between ToM performance and the SAPS persecutory delusion item. These findings provide only partial support for Frith's model. However, difficulties with grouping participants according to high scores on items of these instruments have been discussed above.

Marjoram et al. (2005) used the Hinting task and added ten further hinting items that they had designed for their study. They compared performance of participants with schizophrenia, affective disorder and healthy controls, and found that the group with schizophrenia performed worse than the other two groups and that performance was

more specifically related to positive symptoms, as measured by the Krawiecka scale of psychotic symptoms (Krawiecka, Goldberg & Vaughan, 1977), rather than negative symptoms. However, the authors stated that their study “did not have a particular subgroup of schizophrenia patients with the particular diagnosis of negative features” and that this could account for their lack of findings for negative symptoms. Also, they did not differentiate between types of delusions, instead grouping together persecutory and other delusions and hallucinations into one ‘positive symptoms’ group.

Walston et al. (2000) used half of the items from the Hinting task in their case studies of people with ‘pure’ persecutory delusions, along with a variety of other ToM tasks. Their four participants performed the Hinting task perfectly, which is in direct contradiction to the results obtained by Corcoran et al. (1995) for participants with paranoid symptoms. Although this result is interesting, as it deals exclusively with cases of persecutory delusion with no other symptomatology, the authors acknowledged that their case studies were not a representative sample, and therefore predictions that all patients with persecutory delusions would have unimpaired ToM could not be made.

In summary, the studies that used the Hinting task and looked at differences between symptom subtypes found partial support for Frith’s model, showing that individuals with negative behavioural signs and paranoid delusions or ‘positive symptoms’ scored poorly in different studies.

6.2.1.2 Studies that did not investigate symptom-based subgroups

Janssen et al. (2003) used the Hinting task to compare ToM abilities of individuals with schizophrenia with those of their relatives. They found that participants with schizophrenia were impaired on the Hinting task, as were their relatives (although to a lesser degree). They also administered a false belief task but were unable to show a statistically significant association between schizophrenia risk and ability on this task, suggesting that the Hinting task was a more discriminating measure. Corcoran and Frith (2003) used the Hinting task in their investigation into the possible link between ToM ability and autobiographical memory impairments. They also administered other ToM tasks in the form of stories containing false belief and deception. They found that their participants with schizophrenia were impaired on all tasks, and that there was a significant correlation between scores on the Hinting task and on the ToM stories. Interestingly, they proposed in their paper that there was a possible link between poor ability on ToM tasks and poor autobiographical memory performance. They proposed that poor recall of autobiographical memories prevented their sample from using memories to aid their solving of social inference problems. Corcoran (2003) compared performance of individuals with schizophrenia and healthy controls on the Hinting task, and on an inductive reasoning task. She found a correlation between these tasks in patients with schizophrenia but not in the healthy control sample. She concluded that people with schizophrenia used a different strategy to those without schizophrenia to infer meaning behind pragmatic language, and hypothesised that this difference may underlie poor performance on other social inference tasks.

6.2.2 Gricean Maxims

6.2.2.1 Studies that investigated symptom-based subgroups

One study compared the effects of schizophrenic symptoms on a task involving Gricean maxims (Corcoran & Frith, 1996). Corcoran and Frith (1996) administered their 'Maxims test', which tested adherence to the maxims of quantity, quality, relation (i.e. be relevant- make sure your contributions relate to the exchange) and manner (i.e. avoid being obscure and ambiguous: be brief and orderly) by asking participants to choose the correct one of two pieces of speech which would be most appropriate to end a story. They also tested politeness using the same format. They found that patients with negative symptoms tended to flout all of the maxims apart from the maxim of relation, which was adhered to by all groups. Paranoid patients performed at the same level as healthy controls on the maxims, but not on the test of politeness, on which they performed poorly. Corcoran and Frith (1996) used these results to further interpret the results of their earlier study (Frith & Corcoran, 1996). As detailed above, in this study groups of patients with behavioural signs and paranoid symptoms had difficulties with the Hinting task. Corcoran and Frith (1996) concluded that these two groups had difficulties for different reasons. Those with behavioural signs were ignorant of the conversational rules that were flouted when hinting, while those with paranoid symptoms had difficulties interpreting situations that required on-line mentalising. The results of this study, therefore, were broadly in line with Frith's theory.

6.2.2.2 Studies that did not investigate symptom-based subgroups

Tenyi et al. (2002) compared the performance of participants with schizophrenia and healthy controls on a test that specifically looked at the maxim of relation. They did not

group their sample according to symptoms, and found that their participants with schizophrenia performed at a significantly poorer level than controls. This result is contrary to Corcoran and Frith's (1996) results with this maxim, and could be accounted for because in Tenyi et al. (2002), participants were forced to generate a response for themselves, while in Corcoran and Frith (1996) participants were asked to choose between two answers that were provided for them. Therefore, Tenyi et al.'s (2002) task may have required the use of "on-line" processing and could therefore have been more able to discriminate between individuals with schizophrenia and controls.

6.2.3 Proverbs

6.2.3.1 Studies that did not investigate symptom-based subgroups

Only two studies reviewed here used tests involving the understanding of proverbs, and one of these (Grieg et al., 2004) used Gorham's Proverb Test (Gorham, 1951) as a measure of thought disorder, rather than as a measure of ToM ability. However, Brüne and Bodenstein (2005) investigated whether scores on a ToM cartoon picture-sequencing task were correlated with scores on a task involving the understanding of proverbs. They found that patients with schizophrenia chose the correct answer less frequently than healthy controls on the proverbs task, and that ToM scores predicted scores on the proverbs tasks with a high level of statistical significance. Again, they did not investigate differences according to symptoms.

6.2.4 Metaphor and Irony

6.2.4.1 Studies that investigated symptom-based subgroups

Mitchley et al. (1998) compared the performance of a group of individuals with schizophrenia and a group of psychiatric controls on a task assessing comprehension of irony. The task involved choosing the most appropriate of three possible answers to short pieces of text. They found that the group with schizophrenia was impaired on the task compared to controls, and that negative symptoms were associated with this deficit while positive symptoms were not. They reached this conclusion because scores on the irony task correlated with the negative scale of the PANSS but not the positive scale. However, as discussed above, this methodology does not account for individual differences between participants which could bias the results. Langdon et al. (2002b) used a computer-based understanding of irony and metaphor task. In this task, short stories were presented on a computer screen, culminating in one of the characters making a short statement. Participants were asked to judge whether it made sense for the character to make the statement by pressing 'yes' or 'no'. In this study, Langdon et al. (2002b) found that poor appreciation of irony was associated with high rates of positive formal thought disorder (on the SAPS), while poor appreciation of metaphor was associated with high rates of negative formal thought disorder (on the SANS). They concluded from these results that separate processes were involved in the understanding of metaphor and irony, a result that they found in an earlier study (Langdon et al., 2002a) reported below. The results of these studies were, therefore, in line with Frith's (1992) model, with negative symptoms and positive formal thought disorder both being found to be associated with deficits on the tasks.

6.2.4.2 Studies that did not investigate symptom-based subgroups

Drury et al. (1998) administered false belief tasks, and a task that involved the understanding of a character's knowledge, as well as a task involving the identification of synonyms, similes and metaphors and a task involving the interpretation of metaphor and irony. They asked patients with schizophrenia to complete these tasks during the acute phase of their illness, and then following recovery. They found very mixed results, with individuals with schizophrenia performing as well as controls on the irony task, but not performing as well on either of the metaphor tasks, or some of the false belief tasks. Interestingly, all of the between-group differences disappeared following recovery.

Langdon et al. (2002a) used the computer-based task described above in Langdon et al. (2002b). They also administered a picture-sequencing task involving false belief, social-script, mechanical and 'capture' sequences. The findings from their study led them to conclude that distinct cognitive processes are involved in the interpretation of metaphor and irony and that both of these processes are impaired in people with schizophrenia. They further concluded that the interpretation of irony was a task that required a higher level of theory of mind skill than metaphor, a view that corresponds with that of Happé (1993). Herold et al. (2002) also found some discrimination between metaphor and irony in their study of the performance of patients with schizophrenia in remission compared with a non-psychiatric control group. They presented participants with first and second order ToM stories, and metaphor and irony tasks adapted from the study by Drury et al. (1998). Their sample of participants with schizophrenia in remission performed more poorly than controls on the irony tasks only, suggesting that irony tasks may be a more stringent test of ToM skills than other tasks.

6.3 Summary

Of the fourteen studies reviewed here that investigated ToM deficits in schizophrenia using tasks involving indirect speech, seven reported results based on the subgrouping of participants according to their presenting symptoms, and seven did not. The seven that did not, generally reported that samples with schizophrenia performed worse than controls on these tests. Several studies also showed that tasks assessing indirect speech comprehension were correlated with other ToM tasks (e.g. Corcoran and Frith, 2003) suggesting that the same cognitive skills were being used by participants in both types of task. Of the seven studies that looked at symptom-based subgroups, one (Walston et al. 2000) was a case study design, and one (Marjoram et al., 2005) did not recruit a subgroup with negative features. Of the remaining 5 studies, 2 grouped symptoms in a hierarchical way (Corcoran et al., 1995; Corcoran and Frith, 1996), and 3 used different combinations of PANSS, SAPS and SANS scores (Grieg et al., 2004; Mitchley et al., 1998; Langdon et al., 2002b). Partial support for Frith's theory was found in these studies, with poor performance on tasks reported for those with positive and negative behavioural signs, as well as those with paranoid symptoms.

Taken as a whole, it does seem as if the interpretation of indirect speech can be discriminating as a measure of ToM deficits. However, the studies reported in this section did suffer from the same methodological difficulties discussed previously. One recent development in research in this area has been the harnessing of the schizotypy paradigm to recruit non-clinical samples in order to avoid some of these difficulties. The schizotypy paradigm will be discussed in the following section.

7. The Schizotypy paradigm

7.1 Background

The concept of schizotypy has been developed from observations that schizophrenic symptomatology exists in milder forms within non-clinical populations. For example, studies have demonstrated that psychosis-like symptoms such as magical ideation and hallucinations are reported by large proportions of the general population (e.g. 28.4%, Kendler, Gallagher, Abelson & Kessler, 1996; 20.1%, Poulton et al., 2000). The widespread use of scales of schizotypy in non-clinical samples has left little doubt that psychotic-like features are represented among the general population (Claridge and Beech, 1995).

However, there is debate as to whether schizotypy should be conceptualised as categorical or dimensional, in other words whether or not a continuum exists from low schizotypy at one end through to full-blown psychosis at the other. For example, Meehl (1962) did not see any connection between schizophrenia and schizotypy as a personality continuum, whereas Eysenck (1960) viewed psychiatric disorders, including the psychoses, merely as representing the end-points of continuously variable dimensions. More recently, writers such as Lenzenweger (1993) have tended to define a dichotomous, categorical approach to schizotypy, while Claridge and Beech (1995) have taken a view of schizotypy as a continuous trait across the population.

In a recent paper, Myin-Germeys, Krabbendam and van Os (2003) reviewed studies published between 2000 and 2002 that related to the continuity hypothesis of psychosis. In their review, the authors concluded that there is credible evidence in support of the

suggestion that schizotypal and psychotic experiences lie on a continuum. They found evidence that psychosis-like experiences and psychotic disorder were related to the same demographic, personality, environmental, genetic, neuro-cognitive and psycho-physiological risk factors.

7.2 Measuring schizotypy

Many scales have been developed to measure schizotypy, for example Raine's (1991) Schizotypal Personality Questionnaire, the Schizotypal Personality Scale (STA) of Claridge and Broks (1984), or the Psychoticism Scale (Eysenck & Eysenck, 1975). These questionnaires differ depending on whether they take schizotypy to be a broad construct reflecting the symptoms of Schizotypal Personality Disorder or assume that it is a narrower, more limited concept. There have been a number of attempts to establish the underlying structure of schizotypy, usually by factor analysis. According to Mason and Claridge (2006), a consensus has been reached that schizotypy reduces to three factors- positive schizotypy, negative schizotypy and cognitive disorganisation- that correspond to the three-factor model of schizophrenia (e.g. Liddle, 1987). However, Mason and Claridge (2006) argued that this is too narrow a view of schizotypy, and that a broader concept would more accurately reflect the clinical observation that schizophrenia and affective disorders may share a common biological susceptibility (for more details see Claridge, 1997; Mason and Claridge, 2006). This provides the theoretical framework for the development of their measure of schizotypy, the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE: Mason, Claridge & Jackson, 1995), which was based on the largest study of schizotypal traits undertaken, in which Claridge et al. (1996) used factor analysis to investigate the answers of over 1000

participants to a battery of fifteen psychosis-proneness scales. The O-LIFE has four scales, Unusual Experiences (UnEx), Introverted Anhedonia (IntAn), Cognitive Disorganisation (CogDis), and Impulsive Nonconformity (ImpNon). The first three scales map neatly onto the three factors listed above, with Impulsive Nonconformity as their fourth scale. A full elucidation of the debate concerning the inclusion of this fourth scale is beyond the scope of this paper. However, Mason and Claridge (2006) argued that recent evidence supports their viewpoint, citing a study that reported that questionnaire measures of schizotypy have lacked specificity in distinguishing schizophrenia from bipolar disorder (Heron et al., 2003), and their own work in the development of the scale. Further, various studies have demonstrated that high schizotypy scorers identified using the O-LIFE, demonstrate the same neuro-cognitive deficits as schizophrenic patients (e.g. Burch, Steel & Hemsley, 1998; Goodarzi, Wykes & Hemsley, 2000; Rawlings & Goldberg, 2001).

7.3 Schizotypy research

Whether a three- or four-factor solution is adhered to, the findings reported above suggest that models of neuropsychological function in schizophrenia may be investigated by administering tasks to non-clinical samples which vary in schizotypy (Pickup, 2006). Indeed many studies have done so, investigating, for example, sustained attention (Rawlings & Goldberg, 2001), visuo-spatial processing (Tsakanikos & Reed, 2003) and latent inhibition (Gray, Fernandez, Williams, Ruddle & Snowden, 2002). The advantages of such a strategy are that participants are free from a history of mental health difficulties, which creates many possible confounding effects such as the use of

neuroleptic medication, potential de-socialisation due to prolonged hospital admissions, and lack of attention and concentration when carrying out research tasks.

Recently, several researchers have begun to test ToM in non-clinical populations using a schizotypy paradigm.

7.4 Schizotypy and theory of mind

To date, three studies have investigated the relationship between schizotypy and ToM: Langdon and Coltheart (1999; 2004) and Pickup (2006). As with analogous studies with individuals with schizophrenia, these studies all investigated Frith's (1992) model of the disorder.

Langdon and Coltheart (1999) were the first researchers to study ToM using the schizotypy paradigm. In their 1999 paper, they published the results of two separate experiments. In their first experiment, they tested ToM ability with a picture-sequencing task, where participants were asked to sequence three different types of stories.

'Mechanical' stories depicted sequences of physical cause and effect and tested the ability to infer causal relations. 'Social-script' stories depicted people carrying out everyday social routines and tested ability to reason logically using social-script knowledge. 'False belief' stories featured a character who acted on the basis of information that participants knew to be false. Langdon and Coltheart assessed schizotypy using the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) before administering the picture-sequencing task. For analysis, participants were split into high and low schizotypy groups using a median split of their total SPQ scores.

The results of this study showed that, as predicted by Frith's (1992) theory, high schizotypy participants performed more poorly on the false belief stories than those with low schizotypy, but not on the social-script or mechanical stories. Further, Langdon and Coltheart divided their group into good and poor mentalisers and, using the terminology of Raine et al. (1994), found that those who were rated as poor mentalisers were significantly more likely to report a higher level of interpersonal schizotypal traits than good mentalisers, and that there was a non-significant trend for them to report more cognitive-perceptual traits. 'Interpersonal' traits in this terminology are equivalent to those traits picked up by the Introverted Anhedonia scale of the O-LIFE (i.e. negative schizotypy), and 'cognitive-perceptual' traits are those picked up by the Unusual Experiences scale of the O-LIFE (i.e. positive schizotypy).

Langdon and Coltheart (1999) concluded that this finding was at odds with Frith's theory because, they argued, if psychotic-like symptoms were related to ToM deficits then poor mentalisers should report significantly more 'cognitive-perceptual' traits, which relate directly to psychotic-like experiences. However, Frith's theory states that negative behavioural signs lead to the most widespread ToM deficits, while paranoid symptoms lead to less widespread ToM deficits. Therefore, as negative signs correspond to 'interpersonal' traits and paranoid symptoms to only some of the items on the 'cognitive-perceptual' scale, Langdon and Coltheart's (1999) results do seem to fit with Frith's theory.

In their second experiment, Langdon and Coltheart (1999) included a fourth picture-sequencing task, consisting of 'capture' stories, which depicted a highly salient cue to

mislead participants to sequence the story incorrectly if they relied on that cue. Langdon and Coltheart included this sequence type because they theorised that it was harder than the ToM stories and therefore could control for ceiling effects. They also included the Tower of London task to control for executive function. Their results showed that there were no differences between high and low schizotypes, as measured by the SPQ, on the mechanical, social script and capture stories, but high schizotypes again performed significantly more badly on the false belief stories. Further, in this experiment, poor mentalisers were significantly more likely to rate cognitive-perceptual items (analogous to the O-LIFE UnEx scale) and disorganised items (analogous to O-LIFE CogDis) but did not differ significantly from good mentalisers when rating interpersonal items (analogous to O-LIFE IntAn). This profile differed from that in experiment one, and was considered by the authors to be more in line with Frith's (1992) predictions.

Following their 1999 paper, Langdon and Coltheart published another paper in 2004 with a non-clinical sample. In this study they investigated the effect of schizotypy on the ability to recognise metaphor and irony, following up research that had found that metaphor and irony comprehension is impaired in patients with schizophrenia (Langdon et al., 2002b, described above). In their 2002 study, they found that poor appreciation of irony was associated with high rates of positive formal thought disorder in patients, while poor appreciation of metaphor was associated with high rates of negative formal thought disorder. Langdon et al (2002b) concluded that difficulties with irony could be accounted for by ToM deficits, but difficulties with metaphor were unrelated to ToM, and appeared to be related to abnormal semantics in schizophrenia. In their schizotypy

study, Langdon and Coltheart (2004) hypothesised that non-clinical participants would show a similar profile to those with schizophrenia.

In their 2004 study, Langdon and Coltheart recruited 36 university students, who completed the Schizotypal Personality Questionnaire. They also carried out the same computerised task administered in Langdon et al. (2002a; 2002b), described above. The results of the study showed that the high schizotypal participants had significantly greater difficulty interpreting the ironical statements than those with low schizotypy. Correlation analyses revealed that positive schizotypal traits, in particular cognitive-perceptual traits (i.e. traits measured by the UnEx scale of O-LIFE), may have been more strongly associated with a lack of understanding of irony than metaphor, although this result was compromised by the small sample size. This finding was again in line with the predictions of Frith's (1992) model. This study did not, however, include another measure of ToM, for example a false belief stories task, in order to investigate whether scores on the understanding of irony and ToM tasks correlate in a non-clinical sample. It would also be useful to replicate these findings with a larger sample.

The third study looking at ToM and schizotypy was carried out by Pickup (2006). Pickup used a story task that had been developed for use with non-clinical adults in order to assess ToM through requiring participants to make inferences about the mental states of story characters. The task comprised 16 short stories, each followed by a test question. Eight of the stories were described as 'physical' stories and required reasoning about situations in which people were involved, but required no mental state attribution. The other 8 stories (testing ToM) involved double bluff, mistakes, persuasions and white

lies, and were followed by a question involving an inference about a character's thoughts or feelings. Pickup recruited 62 participants and administered the stories task, as well as the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) to measure schizotypy, and tests of IQ and executive function.

Unlike the previous studies using the schizotypy paradigm, Pickup divided his sample into subgroups according to schizotypy traits that were analogous to the schizophrenic symptoms groupings of Frith's model. The 'behavioural signs' group was made up of those who had scored highly on the Introverted Anhedonia, Cognitive Disorganisation and Impulsive Non-conformity sub-scales. Of the remaining participants, those who had scored highly on the Unusual Experiences subscale made up the 'positive symptoms' group, and any participants who had not been classified were allocated to a 'no symptom' group.

The results of this study showed no association between total schizotypy score and performance on the ToM stories. However, higher scores on the Unusual Experiences scale, which corresponded to positive symptoms, were associated with poorer ToM story task performance (and intact performance on the 'physical' stories).

Inclusion in the behavioural signs subgroup which, according to Frith's model, would have been expected to perform more poorly than the positive symptoms subgroup, was not found to be associated with ToM task scores. Pickup hypothesised that this could have been due to the use of the O-LIFE rather than the SPQ, the scale used by Langdon and Coltheart (1999; 2004). He noted that the SPQ is weighted in favour of items that

correspond to the Unusual Experiences subscale of the O-LIFE, and so the association found by Langdon et al. (2004) may in fact be the association that Pickup found between Unusual Experiences and ToM ability. He further theorised that his design may have contributed to the lack of an association between the behavioural signs subgroup and ToM score. In his design he allowed participants to re-read the stories as many times as they needed, which could have prevented them from having to use their “on-line” mentalising ability.

7.5 Summary

This section summarised the recent developments in the use of the schizotypy paradigm to investigate various aspects of neuropsychological functioning in schizophrenia, in particular in ToM. The theoretical basis of the concept of schizotypy was reported, followed by discussion of its measurement, before the results of the only three studies published to date investigating ToM deficits in a non-clinical sample using the schizotypy paradigm. These studies provided partial evidence for Frith’s model, with individuals scoring high in schizotypy reliably performing poorly on ToM tasks in all the studies. Scales corresponding to the positive symptoms of schizophrenia were also associated with ToM deficits, and in some studies poor mentalisers were significantly more likely to endorse items on scales corresponding to negative signs. More research is needed in this area in order to investigate further the application of this paradigm to ToM.

8. Conclusions

This paper has reviewed the evidence for a ToM deficit in schizophrenia, and found that very strong evidence for such a deficit exists. The main aim of the paper, however, was to assess the evidence for ToM impairments in schizophrenia that would lend weight to Frith's (1992) theory, which predicts that specific schizophrenic symptoms will be associated with differing degrees of ToM impairment. This review has found partial evidence for Frith's (1992) theory, with many published studies providing conflicting findings. That such differing results have been found can be attributed to methodological differences in grouping participants according to symptomatology, difficulties with the use of a proliferation of differing ToM tasks, and the inherent consequences of carrying out research with an extremely heterogeneous, mentally unwell population.

More recently, three studies were published that attempted to solve this latter problem by investigating ToM in individuals who vary in schizotypy. These studies again provided partial support for Frith's (1992) model, which may have been due to the use of different measures of ToM ability and schizotypy, as well as different ways of grouping their participants according to schizotypal traits. Further investigation with non-clinical samples is needed. In particular, investigations using tasks that aim to tap into "on-line" processing skills of participants would be useful, as well as tasks that are sensitive to subtle differences in ToM abilities.

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Part 2: Empirical paper

1. Abstract

Following Frith's (1992) suggestion that many of the symptoms of schizophrenia are associated with theory of mind (ToM) impairments, several studies have found associations in non-clinical samples between poorer performance on ToM tasks and schizotypal traits (Langdon & Coltheart, 1999; Langdon & Coltheart, 2004; Pickup, 2006). This study aims to replicate and extend these findings.

Seventy-two healthy individuals were recruited and completed a schizotypy questionnaire (the Oxford-Liverpool Inventory of Feelings and Experiences; O-LIFE), as well as ToM stories task and understanding of irony stories task. Executive function was assessed using the Brixton test, and full-scale IQ was predicted using the WTAR. Schizotypal traits analogous to positive symptoms of schizophrenia predicted performance on the irony task, while IQ predicted performance on the other ToM task. There was no association between schizotypal traits analogous to "behavioural signs" of schizophrenia and performance on either task.

This study concluded that positive schizotypal traits in healthy individuals are associated with ToM impairments, independent of executive function or IQ. The association between "behavioural signs" and poor ToM may only occur in patients with schizophrenia. Reasons for these findings are discussed in light of Frith's model.

2. Introduction

2.1 Frith's cognitive neuropsychological model

Frith's (1992) cognitive neuropsychological model of schizophrenia suggested that the symptoms of schizophrenia could be accounted for in terms of impairments in Theory of Mind (ToM), the ability to represent one's own and others' mental states. Difficulty with the representation of others' mental states is widely accepted as underlying the so-called triad of impairments in Autistic Spectrum Disorder (Wing, 1979), and many studies have investigated the performance of individuals with schizophrenia on ToM tasks since Frith's (1992) theory was first developed (for detailed reviews, see Brüne, 2005; Harrington, Siegert & McClure, 2005).

Frith's (1992) model made clear predictions concerning the performance of individuals with schizophrenia on ToM tasks. These predictions were based on the way that Frith classified schizophrenic symptomatology. Within his theoretical framework, a distinction was made between the bizarre experiences and beliefs that a person with schizophrenia can describe ('symptoms') and the behavioural abnormalities that can be observed ('signs'). Using this classification, Frith (1992) postulated a hierarchy of impairments on ToM tasks. First, individuals with negative (e.g. flat affect, social withdrawal) or positive (e.g. incoherent speech) behavioural signs should score very poorly on the tasks, scoring similarly to those with autism, because the model states that these people are unable to represent any mental states. Secondly, those with paranoid symptoms (e.g. persecutory delusions) but no behavioural signs should be less impaired than those with behavioural signs but more impaired than controls, because these people were theorised to be able to represent mental states but to make errors while doing so.

Finally, people with passivity symptoms (e.g. thought insertion) and those in remission should score at the same level as controls, as they were presumed to have no ToM deficit.

2.2 Evidence for the model

Investigations of ToM ability in schizophrenia have shown conclusively that patients show impaired performance on ToM tasks when compared to healthy and psychiatric controls. Individuals with positive behavioural signs have performed consistently poorly across studies (Doody, Götz, Johnstone, Frith & Cunningham Owens, 1998; Grieg, Bryson & Bell, 2004; Sarfati and Hardy-Baylé, 1999; Sarfati, Hardy-Baylé, Besche & Widlöcher, 1997; Sarfati, Hardy-Baylé, Brunet & Widlöcher, 1999; Sarfati, Hardy-Baylé, Nadel, Chevalier & Widlöcher, 1997) as have those with negative behavioural signs (Corcoran, Cahill & Frith, 1997; Corcoran, Mercer & Frith, 1995; Frith and Corcoran, 1996). The picture for individuals with paranoid symptoms is more mixed. Several studies (Corcoran et al., 1995; 1997; Corcoran & Frith, 1996; Frith & Corcoran, 1996; Marjoram et al., 2005; Pickup & Frith, 2001) have shown that patients with paranoia or persecutory delusions do show ToM deficits, while others have been unable to show such a link (Grieg et al., 2004; Langdon, Coltheart, Ward & Catts, 2001; Mazza, De Risio, Surian, Roncone & Casacchia, 2001; Walston, Blennerhassett & Charlton, 2000). Studies that investigated patients in remission have found a similarly mixed picture. While several showed no difference between a remitted group and controls (Corcoran et al., 1995; 1997; Frith & Corcoran, 1996) one study showed that patients in remission performed at the same level as symptomatic patients on ToM tasks (Randall, Corcoran, Day & Bentall, 2003).

These mixed findings should be considered in the light of several limitations that make generalising across studies difficult. Firstly, a wide range of tasks has been used to test ToM performance, including verbal and non-verbal tasks, tasks that involve false belief or deception, jokes or the understanding of non-literal speech. It is not clear that these tasks all measure the same underlying construct, especially as their psychometric properties have not been firmly established in any of the studies that employed them (Harrington et al., 2005). Secondly, the studies have used different methods of grouping their participants. Because Frith's theory made specific predictions based on different symptoms, it is important that studies ensure that each subgroup of participants does not contain individuals whose symptoms belong to a different subgroup. Because of the heterogeneity of symptoms within individuals with schizophrenia, this is very difficult to achieve. The third group of limitations represents the difficulties inherent in carrying out research with a psychiatrically unwell population. These include small sample sizes, the effects of medication and hospitalisation, and difficulties with concentration and attention.

2.3 Schizotypy

Several studies have used the schizotypy paradigm in order to minimise the experimental difficulties associated with investigations of individuals with schizophrenia. The sub-clinical expression of schizophrenic symptoms in the normal population has been variously termed schizotypy, psychoticism, or psychosis-proneness (Claridge, 1994).

Schizotypal traits can be measured in the normal population using self-report questionnaires such as the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE: Mason, Claridge & Jackson, 1995), which was developed through factor analysis of a variety of schizotypy scales, and focuses on four dimensions of schizotypy. Three of these map onto Liddle's (1987) three-factor model of schizophrenia: a positive factor (Unusual Experiences, UE), a negative factor (Introverted Anhedonia, IA), and a disorganisation factor (Cognitive Disorganisation, CD). The fourth dimension, Impulsive Nonconformity, IN, was largely based on Eysenck's Psychoticism scale (Tsakanikos & Reed, 2003).

Individuals high in schizotypy have been found to resemble individuals with schizophrenia in various aspects of neuropsychological functioning, for example sustained attention (Rawlings & Goldberg, 2001), visuo-spatial processing (Tsakanikos & Reed, 2003) and latent inhibition (Gray, Fernandez, Williams, Ruddle & Snowden, 2002). These findings have added weight to the premise that the schizotypy paradigm can be thought of experimentally as analogous to schizophrenia.

2.4 Schizotypy and theory of mind

To date, three studies have investigated the relationship between schizotypy and theory of mind in order to test Frith's (1992) model. Langdon and Coltheart (1999) published the results of two separate experiments. They tested ToM ability with a picture-sequencing task and assessed schizotypy using the Schizotypal Personality Questionnaire (SPQ: Raine, 1991). For analysis, participants were split into groups of high and low schizotypy using a median split of their total SPQ scores. The results of

these studies showed that, as predicted by Frith's (1992) theory, high schizotypy participants performed more poorly on the ToM task than those with low schizotypy. They also divided their samples into good and poor 'mentalisers'. In their first experiment poor mentalising was significantly associated with schizotypal traits analogous to negative signs of schizophrenia and in their second experiment poor mentalising was significantly associated with traits analogous to positive symptoms.

Langdon and Coltheart (2004) investigated the effect of schizotypy on the ability to recognise metaphor and irony, following up previous research that found that metaphor and irony comprehension was impaired in patients with schizophrenia, and that the impairment on irony tasks was associated with poor performance on conventional ToM tasks (Langdon, Davies & Coltheart, 2002). Their participants again completed the SPQ and carried out a computerised task that tested their understanding of metaphor and irony. The results showed that high schizotypal participants had significantly greater difficulty interpreting the ironical statements than those with low schizotypy, in line with the predictions of Frith's (1992) model. Unlike Langdon et al.'s (2002) study with individuals with schizophrenia, this study did not include another measure of ToM, for example a false belief stories task, in order to investigate whether scores on the understanding of irony task and false belief task were correlated in a non-clinical sample.

The third study looking at theory of mind and schizotypy was carried out by Pickup (2006). This study used a story task that had been developed for use with healthy adults in order to assess ToM through requiring participants to make inferences about the

mental states of story characters. Pickup (2006) also administered the O-LIFE (Mason et al., 1995) to measure schizotypy, as well as tests of IQ and executive function. The sample was divided into sub-groups according to schizotypy traits that were analogous to the schizophrenic symptom groupings of Frith's (1992) model. The results of this study showed that higher scores on the Unusual Experiences scale of the O-LIFE, which corresponded to positive symptoms, were associated with poorer ToM story task performance, while there was no association between total schizotypy score and performance on the ToM stories. Pickup (2006) hypothesised that his lack of findings for total schizotypy could have been due to the use of the O-LIFE rather than the SPQ. He found that inclusion in the behavioural signs subgroup was not found to be associated with ToM task scores (contrary to predictions from Frith's (1992) model), and he suggested that this may have been because participants were able to re-read the stories as many times as needed, which could have prevented them from having to use their "on-line" mentalising ability. "On-line" mentalising refers to that which takes place during an interaction, and may utilise different skills from that which would take place at an individual's own pace. It may be that difficulties in mentalising are more apparent when the pace of mentalising is dictated by the interaction, rather than individuals allowing themselves more time, for example to re-read tasks. The mode of presentation of tasks, therefore, may give rise to greater or lesser discrimination between individuals' ToM ability.

In summary, the findings from studies investigating ToM ability and schizotypy have produced similarly inconsistent findings to those that investigated ToM ability in schizophrenic populations. Schizotypal traits analogous to both negative signs and

positive symptoms have been found to be associated with ToM deficits in different studies, and task presentation has been hypothesised to affect ToM ability. Only Pickup (2006) divided his participants into groups based on Frith's classification.

2.5 The present study

This study aims to further investigate the link between ToM ability and schizotypy. Specifically, the study will administer the O-LIFE and the ToM story task administered by Pickup (2006) in order to replicate his findings. An irony task taken from Mitchley et al. (1998) (in which it was administered to individuals with schizophrenia) will also be used with the aim of replicating Langdon et al.'s (2004) finding of an association between schizotypy and irony comprehension. This will also allow investigation of whether the correlation between scores on ToM tasks and irony tasks, found in Langdon et al. (2002) in individuals with schizophrenia, can be found in a non-clinical sample. In addition, the study aims to investigate whether the presentation of tasks in such a way that maximises "on-line" ToM processing will allow the detection of associations between ToM and all the dimensions of schizotypy as predicted by Frith's (1992) model. It will be important to control for IQ in this study because, as Pickup and Frith (2001) reported, deficits in ToM ability may be compensated for by IQ-dependent problem-solving skills. Furthermore, patients with schizophrenia can show deficits in executive functioning (e.g. Hutton et al., 1998), which has also been shown to vary with schizotypy (e.g. Raine, Sheard, Reynolds, & Lencz, 1992), and therefore will be controlled for in the present study.

It is predicted that an association will be found between poorer performance on the ToM stories task and higher schizotypy scores, and between poorer irony task performance and higher schizotypy scores. Secondly, in line with Frith's (1992) theory, it is predicted that impairments on the ToM stories and irony tasks will be associated with schizotypal traits analogous to behavioural signs, and, to a lesser extent, schizotypal traits analogous to positive symptoms, while individuals low in schizotypy are hypothesised to perform at normal levels on both tasks. Finally, a correlation is predicted between ToM story task scores and irony task scores.

3. Methods

3.1 Design

This study used a cross-sectional correlational design to investigate the relationship between schizotypy and performance on ToM tasks.

3.2 Participants

In estimating the number of participants required, Cohen's (1992) formula was used. This formula is: $f^2 = R^2 / 1 - R^2$, where f^2 is the effect size index and R^2 is the size of the correlation. In his investigation of the relationship between ToM score and schizotypy, Pickup (2006) found a significant value of $R^2 = 0.122$ in a multiple regression, and this figure was used to calculate the sample size of the present study. Therefore, to estimate effect size, the following calculation was undertaken in line with Cohen's (1992) formula: $0.122 / (1 - 0.122) = 0.14$. This corresponded to a medium effect size (0.15). With a medium effect size, Cohen's table of sample sizes, given a 0.05 significance level, gives an N of 76. Therefore the sample size that this study aimed to recruit was approximately 76.

Seventy-two participants were recruited by sampling a student population. Inclusion criteria were English as first language, an age between 18 and 50 and no history of psychiatric illness or head injury. As in Pickup (2006), the Schizotypal Personality Scale (STA) of the Claridge and Broks (1984) Schizotypy Questionnaire (STQ) was used to screen participants to ensure that the sample represented a broad range of schizotypy (see appendix 2). Following Pickup (2006), participants were classified as "average" schizotypes if they scored within one standard deviation (SD) of the population mean on

the STA, “low” schizotypes if they scored more than 1 *SD* below the population mean and “high” schizotypes if they scored more than 1 *SD* above the population mean.

In total, 52 females and 20 males participated in the study. Their ages ranged from 19 to 35 years, mean (*SD*) = 22.4 (3.5).

Ten participants fell within the “low” range on the STA: 2 male, 8 female; mean (*SD*) age = 24.9 (4.1). Fifty-one participants fell within the “average” range: 12 male, 39 female; mean (*SD*) age = 22.0 (3.2). Eleven participants fell within the “high” range: 6 male, 5 female; mean (*SD*) age = 21.8 (3.6).

As in Pickup (2006), the Lie Scale of the Short Form of the Eysenck Personality Questionnaire-Revised (EPQ-R; Eysenck & Eysenck, 1991) was incorporated into the STA. This assessed participants’ tendency to give socially desirable but untruthful answers to 12 questions, and was included in order to give an indication of the reliability of participants’ answers on the other measures. In Pickup (2006), a score of more than 1 *SD* above the population mean on the Lie Scale led to exclusion from the study. However, in this study, scores on the Lie Scale were very low, ranging from 0-2 out of 12, and so no participants were excluded on this basis.

3.3 Measures

Following screening, participants completed the following measures in the order shown:

3.3.1 The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE)

A self-report measure of schizotypy devised by Mason, Claridge and Jackson (1995), the O-LIFE consists of between 24 and 30 questions on each of four scales: “unusual experiences” (UE); “cognitive disorganisation” (CD); “impulsive nonconformity” (IN) and “introvertive anhedonia” (IA) (see appendix 3). Because schizotypy is known to vary with age and sex, raw scores on these scales were standardised using Mason and Claridge’s (2006) population norms.

3.3.2 The Wechsler Test of Adult Reading (WTAR)

The WTAR requires participants to read aloud a list of 50 words which have irregular spellings, giving a score out of 50 which represents the number of words correctly pronounced. It has a high internal consistency in the range 0.87-0.95 across ages. Also, the WTAR has high test-retest reliability (r in range 0.90-0.94) (Wechsler, 2001).

Because it was developed and co-normed simultaneously with the widely-used WAIS–III, the WTAR is a simple and effective method of estimating full-scale IQ. The WTAR displays high positive correlations (r in range 0.63-0.80) with full-scale IQ (Wechsler, 2001). Raw scores were converted to an estimate of full-scale IQ using standard conversion tables (Wechsler, 2001).

3.3.3 The Brixton Test

In this short measure of executive function developed by Burgess and Shallice (1997), participants are shown a series of pages showing the same basic array of 10 circles, one of which is coloured blue. The position of this coloured circle changes from page to page according to rules that change several times during the test. The participant is asked to predict where the coloured circle will move next. The test is scored through a count of the number of errors made, with the raw score of between 0 and 54 errors being converted to a scaled score of 1 to 10, with 10 indicating 0-7 errors and being classified as “very superior” and 1 indicating over 31 errors and being classified as “impaired”. Burgess and Shallice (1997) reported that the Brixton test has a high test-retest reliability ($r = 0.71$), as well as good split-test reliability ($r = 0.62$), and suggested that this test is sensitive to problems in rule detection and tendencies toward impulsive behavior and provides a purer measure than related tasks, such as the Wisconsin Card Sorting Test (Heaton, Chelune, Talley, Kay & Curtis, 1981). It was included to provide a control for executive difficulties with generativity or inhibition.

3.3.4 Theory of mind (ToM) and ‘physical’ control stories

The ToM task used in this study (see appendix 4) was adapted from Pickup (2006) to facilitate replication. The task comprises 16 short passages, followed in each case by a test question. Eight of the stories are used as measures of ToM, involving double bluff, mistakes, persuasions and white lies based on Happé’s (1994) ‘Strange Stories’ and developed for use with adults by Fletcher et al. (1995). Each is followed by a question requiring an inference about a character’s thoughts and feelings. The other 8 stories, the ‘physical’ stories, were also developed by Fletcher et al. (1995) and require reasoning

about situations in which people are involved, but do not require the attribution of mental states.

As discussed in the previous section, this study aimed to maximise participants' reliance on their "on-line" mentalising ability. With this in mind, in the present study the stories were recorded onto compact disc and presented to participants aurally. Participants were only able to hear the stories once before answering out loud. It was felt that this method of presentation most closely represented conversational interactions in the real world. Responses were recorded for later transcription and scoring, using the standard criteria detailed in Pickup (2006). Because their responses were recorded, it was also possible to measure accurately the time between the end of the test question and the beginning of participants' answers. This time was recorded for later analysis.

The stories were presented randomly and in this respect the present study also differs from Pickup (2006), who presented all stories of one type together.

3.3.5 Understanding of irony and literal control stories

The understanding of irony task (see appendix 5) was chosen for its similarity to the stories task described above and is based on a task that Mitchley et al. (1998) used with individuals with schizophrenia. The task consists of 18 items. In 9 of the items, the correct identification of the use of irony is necessary in order to give a correct response, while in the other 9 no irony is employed and the statements are designed to be interpreted literally. In the original task, each item consisted of a short statement, followed by three possible answers, with participants being asked to select the one that

they felt made most sense. In the present study, the three possible answers were not presented to participants, in order to make the format of the task closer to that of the ToM and physical stories, where participants were free to respond in any way they wished. The irony and literal stories were also recorded onto compact disc for aural presentation and were presented randomly intermixed with the ToM and physical stories. It was felt important that the stories were as similar as possible to minimise the risk of participants recognising story formats.

3.4 Procedure

Participants were tested individually in a quiet room, having been given written information about the study (see appendix 6) and having had the opportunity to ask questions. After giving written, informed consent to take part (see appendix 6), tasks were administered in the order listed above. The procedure took between forty minutes and one hour to complete, and participants were reimbursed for their time.

3.5 Ethics

The study was approved by the local University College London Research Ethics Committee (see appendix 7).

4. Results

4.1 Questionnaire data

4.1.1 Schizotypy scales

The means, standard deviations (SD) and range of scores for the whole sample on the questionnaire measures used are shown in Table 1. Raw O-LIFE scores were converted to standard scores for analysis using Mason et al.'s (2006) updated sex and age norms (standard score = (raw score – norm mean score) / SD). The total O-LIFE standard score was then the sum of the standard scores for each sub-scale.

Table 1:

Mean (SD) and range of scores on the questionnaires

<i>Scale</i>	<i>Mean (SD)</i>	<i>Range</i>
STA	15.49 (6.88)	2-35
O-LIFE: Unusual experiences (UE)	8.94 (6.49)	0-26
O-LIFE: Cognitive disorganisation (CD)	11.22 (5.25)	2-24
O-LIFE: Introvertive anhedonia (IA)	4.54 (3.43)	0-13
O-LIFE: Impulsive nonconformity (IN)	8.99 (3.48)	2-18
O-LIFE: Total score	33.82 (13.44)	13-70

The presence of outliers in the questionnaire data was investigated. Participants whose score on a variable fell more than 3 standard deviations away from the sample mean had that score excluded from further analysis. In the questionnaire data, one participant's score on the Introvertive Anhedonia subscale was excluded ($z = 3.9$). No other participants' scores were excluded.

All of the scores on the questionnaires were normally distributed, so it was not necessary to carry out any transformations in order for parametric analyses to be carried out.

4.2 IQ and Brixton test scores

The mean (SD; range) full-scale IQ of the sample as measured by the WTAR was 115.72 (6.58; 97-127). The mean (SD; range) score on the Brixton test was 7.54 (1.33; 6-10).

The presence of outliers was also investigated for these tests. One participant's Full-Scale IQ score was excluded ($z = 3.29$). Scores on the Brixton test were normally distributed, but standard scores on the WTAR were negatively skewed. In order for the assumption of normality required for parametric analysis to be fulfilled, the WTAR standard scores were reflected and a square root transformation was applied. The reflected and transformed scores were normally distributed.

4.2.1 Relationship between schizotypy and executive function

In order to investigate previous findings that high schizotypy is associated with poor executive function (e.g. Raine et al., 1992), a correlation analysis was carried out. This revealed no association between total O-LIFE scores and scores on the Brixton test: Pearson's $r = -0.136$; $p = 0.253$.

4.2.2 Relationship between schizotypy and IQ

Tsakanikos and Reed (2003) reported that, contrary to the intellectual decline found in schizophrenia, they found no association between IQ, as measured in their study using the Raven's Progressive Matrices, and O-LIFE scores. In the present study, predicted full-scale IQ and total O-LIFE scores were also found to be unrelated (Pearson's $r = 0.064$; $p = 0.594$).

4.3 The stories tasks

4.3.1 Missing data analysis

A small number of participants missed out one or more of the stories, reporting that they did not hear them properly. However, because of the small number of stories missed out (less than 5% of the dataset), no participants were excluded from subsequent analysis on this basis. Due to the small numbers involved, it was felt that a missing cases analysis would have been inappropriate, as there would have been insufficient power to establish non-randomness of missing data.

4.3.2 Scores on stories tasks

Participants were awarded a score of 0, 1 or 2 on each of the ToM, physical, irony and literal stories, following Happé's scoring system, also used by Pickup (2006). A score of 2 was given for a full and explicitly correct answer, and a score of 1 was given for a partial or implicit answer. A sub-set of 20 data sets was scored by a second rater, who was blind to the study hypotheses, and agreement between the scorers was good (88%).

Because some participants did not answer some of the stories, it was not possible to use total story scores for analysis, and mean scores were used instead.

For the whole sample, the means, SDs and range of mean scores on the four story types are given in Table 2.

Table 2:

Whole sample story data

<i>Story type</i>	<i>N</i>	<i>Mean (SD)</i>	<i>Range</i>
ToM	70	1.78 (0.18)	1.38-2.00
Physical	71	1.57 (0.27)	0.88-2.00
Irony	69	1.88 (0.15)	1.44-2.00
Literal	71	1.76 (0.27)	1.00-2.00

The presence of outliers was investigated in the story data. One outlier was removed from ToM stories and one from the irony stories ($z = 3.76$ and 3.24 respectively). No outliers were found in either the physical or literal stories. Following removal of the outliers, the scores were tested for normality.

Mean ToM and physical story scores were both normally distributed. Mean irony and literal story scores were significantly negatively skewed so were transformed in order to meet the assumptions for normality required for parametric analyses: scores were reflected and then a constant, 3, was added to each to ensure that no score fell below zero, before their inverse was calculated. This removed the skewness.

There was a statistically significant difference between the mean scores on the ToM and physical stories (within-subjects t -test: $t(69) = 6.40$; $p < 0.001$, 2-tailed) and the irony and literal stories (within-subjects t -test: $t(68) = 3.19$; $p = 0.002$, 2-tailed). This showed that, contrary to the findings of Fletcher et al. (1995) and Pickup (2006), participants found the physical stories more difficult than the ToM stories. Participants also appeared to have found the literal stories more difficult than the irony stories.

4.3.3 Correlation between ToM and irony scores

In order to give an indication of whether the ToM stories task and the irony stories task were both measuring the same underlying construct, a correlation analysis of scores on the two tasks was carried out. This showed that scores on these tasks were significantly correlated: Pearson's $r = 0.267$; $p = 0.027$, 2-tailed. This analysis was repeated controlling for IQ and executive function scores, and the association remained: Pearson's $r = 0.274$; $p = 0.026$.

4.3.4 Median split analyses by total schizotypy score.

4.3.4.1 ToM and physical stories

In order to enable comparison with Langdon and Coltheart (1999) and Pickup (2006), participants were split into two sub-groups based on a median split of their total O-LIFE standard scores (median = -0.92). A two-way mixed analysis of variance (ANOVA) was carried out with two levels on the between factor of subject group (low vs. high schizotypy) and two levels on the repeated factor of story type (ToM vs. physical). This revealed a significant main effect of story type ($F(1, 68) = 41.63$; $p < 0.0001$), which reflected the fact that participants scored significantly more poorly on the physical

stories than the ToM stories, and a non-significant main effect of subject group ($F(1, 68) = 1.44$; $p = 0.24$). This reflected the fact that neither group (high vs. low schizotypy) performed significantly more poorly on all the stories (both ToM and physical). The story type x group interaction was also not significant ($F(1, 68) = 1.53$; $p = 0.22$).

4.3.4.2 Irony and literal stories

The analysis was repeated for the irony and literal stories, and again revealed a significant main effect of story type ($F(1, 67) = 10.14$; $p = 0.002$), consistent with participants scoring higher on the irony stories than the literal stories. The main effect of subject group was not significant ($F(1, 67) = 3.16$; $p = 0.08$), nor was the story type x group interaction ($F(1, 67) = 0.327$; $p = 0.569$).

4.3.4.3 Summary

The study showed that median split analyses using O-LIFE total scores do not reveal significant differences in ToM/ physical story performance, which replicates the results of Pickup (2006). For the irony stories, similar results were found, although there was a trend for poor performance on the irony and literal story task taken as a whole to be associated with higher O-LIFE scores.

4.3.5 Symptom subgroup analyses.

In order to test the hypothesis that schizotypal traits analogous to the “behavioural signs” and “positive symptoms” of schizophrenia would be associated with poorer performance on the story tasks, participants were split into groups based on Frith’s (1992) model of schizophrenia. The grouping method that was used in this study was

that of Pickup (2006). Participants were allocated to a “behavioural signs” subgroup (N=18) if their sum of standard scores on the IA, IN and CD subscales of the O-LIFE was greater than 1. Of the remaining participants, if their standard score on the UE subscale of the O-LIFE was greater than 1 they were placed in the “positive symptoms” subgroup (N=3) and all other participants were placed in a “no symptoms” subgroup (N=51).

However, it was felt that it was not valid to carry out statistical analyses with groups that contained such different numbers of participants, especially when one group contained an N of 3. It was decided, therefore, that it was not possible to carry out this analysis. This issue is addressed more fully in the discussion.

4.3.6 Regression analysis

To facilitate comparison with Langdon and Coltheart (1999) and Pickup (2006), the relation between O-LIFE subscale standard scores and scores on the stories tasks for the whole sample was investigated using hierarchical multiple regression. To control for full- scale IQ (IQ) and executive function (Efn), standardised scores on the WTAR were entered on step 1 of the regression and scores on the Brixton test were entered on step 2. Following the methodology of Pickup (2006), a behavioural signs schizotypy composite (B) was created that consisted of the sum of the standard scores on the IA, IN and CD subscales of the O-LIFE, with the UE subscale standard scores making a ‘positive symptoms’ variable (P). The behavioural signs composite was entered on step 3 of the regression and the positive symptoms composite on step 4.

Separate regressions were carried out with mean ToM score, mean physical score, transformed mean irony score and transformed mean literal score as dependent variables. All regressions met the assumption of homogeneity of variance, had normal distributions of standardised residuals and showed no influence of outliers. The regression models are shown in Tables 3 and 4 for ToM/Physical and Irony/Literal stories respectively, with findings significant at a 0.05 alpha level highlighted in bold.

4.3.6.1 ToM and physical stories

Table 3:

Hierarchical multiple regression for ToM/ physical stories

<i>Regression model</i>	<i>ToM stories</i>	<i>Regression model</i>	<i>Physical stories</i>
R ² (IQ)	0.069	R ² (IQ)	0.056
F(1,67)	4.961; p=0.029*	F(1,68)	4.045; p=0.045*
β (IQ)	0.263; p=0.029*	β (IQ)	0.237; p=0.048*
R ² (IQ+Efn)	0.0708	R ² (IQ+Efn)	0.059
F(2,66)	2.516; p=0.088.	F(2,67)	2.100; p=0.130
β (IQ)	0.260; p=0.032*	β (IQ)	0.242; p=0.046*
β (Efn)	0.044; p=0.714	β (Efn)	-0.053;p=0.66
Finc(1,66)	0.135; p=0.714	Finc(1,67)	0.202; p=0.655
R ² (IQ+Efn+B)	0.0711	R ² (IQ+Efn+B)	0.122
F(3,65)	1.660; p=0.184	F(3,66)	3.058; p=0.034
β (IQ)	2.60; p=0.034*	β (IQ)	0.230; p=0.052
β (Efn)	0.047; p=0.702	β (Efn)	-0.101;p=0.394
β (B)	0.017; p=0.886	β (B)	-0.256;p=0.033*
Finc(1,65)	0.021; p=0.886	Finc(1,66)	4.739; p=0.033*
R ² (IQ+Efn+B+P)	0.097	R ² (IQ+Efn+B+P)	0.124
F(4,64)	1.709; p=0.159	F(4,65)	2.299; p=0.068
β (IQ)	0.288; p=0.020*	β (IQ)	0.237; p=0.046*
β (Efn)	0.066; p=0.590	β (Efn)	-0.096;p=0.425
β (B)	0.239; p=0.247	β (B)	-0.194;p=0.346
β (P)	-0.272; p=0.185	β (P)	-0.076;p=0.708
Finc(1,64)	1.797; p=0.185	Finc(1,65)	0.142;p=0.708

* = significant at p < 0.05

This table shows that full-scale IQ was the only significant predictor of ToM story scores, remaining significant with the inclusion of the other variables in the model, with higher IQ being associated with a higher ToM story score, $\beta(\text{IQ}) = 0.288$; $p = 0.020$. Full-Scale IQ also predicted performance on the physical stories, again with higher IQ being associated with better story performance, $\beta(\text{IQ}) = 0.237$; $p = 0.046$. For the physical stories, the inclusion of the behavioural signs composite also significantly increased the proportion of variance explained, with increased Behavioural signs associated with decreased story score, $\beta(\text{B}) = -0.256$; $p = 0.033$. Interestingly, this result disappeared with the inclusion of the Positive symptoms scores in the model, suggesting that this was not a robust finding.

4.3.6.2 Irony and literal stories

Table 4:

Hierarchical multiple regression for irony/ literal stories

<i>Regression model</i>	<i>Irony stories</i>	<i>Regression model</i>	<i>Literal stories</i>
R ² (IQ)	0.0156	R ² (IQ)	0.032
F(1,66)	1.046; p=0.310	F(1,68)	2.256; p=0.138
β (IQ)	0.125; p=0.310	β (IQ)	0.179; p=0.138
R ² (IQ+Efn)	0.0157	R ² (IQ+Efn)	0.041
F(2,65)	0.519; p=0.598	F(2,67)	1.435; p=0.245
β (IQ)	0.126; p=0.312	β (IQ)	0.170; p=0.161
β (Efn)	-0.10; p=0.936	β (Efn)	0.095; p=0.432
Finc(1,66)	0.007; p=0.936	Finc(1,67)	0.626; p=0.432
R ² (IQ+Efn+B)	0.0162	R ² (IQ+Efn+B)	0.0607
F(3,64)	0.350; p=0.789	F(3,66)	1.421; p=0.244
β (IQ)	0.125; p=0.317	β (IQ)	0.164; p=0.177
β (Efn)	-0.01; p=0.915	β (Efn)	0.068; p=0.576
β (B)	-0.02; p=0.864	β (B)	-0.14; p=0.245
Finc(1,65)	0.030; p=0.864	Finc(1,66)	1.379; p=0.245
R ² (IQ+Efn+B+P)	0.087	R ² (IQ+Efn+B+P)	0.0614
F(4,63)	1.492; p=0.215	F(4,65)	1.063; p=0.382
β (IQ)	0.173; p=0.164	β (IQ)	0.162; p=0.174
β (Efn)	0.017; p=0.893	β (Efn)	0.072; p=0.565
β (B)	0.351; p=0.098	β (B)	-0.11; p=0.620
β (P)	-0.46; p=0.031*	β (P)	-0.05; p=0.827
Finc(1,64)	4.852; p=0.031*	Finc(1,65)	0.048; p=0.827

* = significant at p < 0.05

There was no association between scores on the Irony stories and IQ, executive function or Behavioural signs. However, Positive symptoms were associated with a lower Irony story score, $\beta(P) = -0.46$; $p = 0.031$, and addition of this predictor to the model significantly increased the proportion of variance explained, $F_{inc}(1,64) = 4.852$; $p = 0.031$. Scores on the literal stories were not significantly related to any of the predictor variables.

4.3.6.3 Correction for Type I error

In order to minimise the risk of Type I error, it was felt important to test at a conservative alpha of $0.05/2$ (0.025). This level of alpha was adopted because two pairs of regressions were carried out, and this constituted a more rigorous approach. With this conservative alpha, the finding that IQ predicts ToM story scores remained significant, while the other findings were reduced to strong trends.

4.3.6.4 Summary

IQ was the only robust predictor of scores on the ToM stories and there was a strong trend that IQ predicted physical story scores. There was also a strong trend for schizotypal traits analogous to positive symptoms of schizophrenia to predict irony scores, while none of the variables predicted literal story scores.

4.4 Story response times

Because participants' responses to stories were recorded onto cassette as the stories were playing, it was possible to capture this information onto a PC and, through study of the waveforms, obtain an accurate response time for each story. Median times were

calculated for each participant per story type, and were analysed in the same way as the story scores reported above. Due to space restrictions, only significant, relevant results will be reported.

For the whole sample, the means, SDs and range of median response times on the four story types are given in Table 5.

Table 5:

Mean time data

<i>Story type</i>	<i>N</i>	<i>Mean (SD)/sec</i>	<i>Range/sec</i>
ToM	70	1.56 (0.63)	0.73-4.36
Physical	71	2.04 (0.95)	0.88-5.68
Irony	69	1.73 (0.74)	0.92-5.14
Literal	71	2.46 (1.35)	0.88-7.95

No outliers were found in these variables. Median times for all stories were significantly positively skewed. ToM and physical story times were log transformed and irony and literal stories were inversely transformed in order to fulfil the assumption of normality necessary for parametric tests. These transformations removed the skewness.

As with the story scores, there was a significant difference between the median times on the ToM and physical stories (within-subjects t -test: $t(71) = -6.64$; $p < 0.001$, 2-tailed), with participants taking longer to answer physical stories, and the irony and literal stories (within-subjects t -test: $t(71) = 8.96$; $p = 0.002$, 2-tailed), with participants taking longer to answer literal stories. This gives more weight to the hypothesis that the

physical and literal stories were found more difficult by participants than the ToM and irony stories.

4.4.1 Correlation between times for ToM and irony scores

An analysis was performed to establish whether median times on the ToM and irony stories were correlated. This showed that the transformed median times were significantly negatively correlated (Pearson's $r = -0.685$; $p < 0.0001$). The negative correlation is explicable by the nature of the transformations used, and is consistent with higher response times on the ToM and irony stories being associated with each other. This significant association remained when Full-Scale IQ and executive function were controlled for (Pearson's $r = -0.724$; $p < 0.0001$).

4.4.2 Median split analyses by total schizotypy score.

Median split analyses showed no significant relationships between high and low schizotypy and median response times for any story type.

4.4.4 Regression analysis

Regression analyses with median times as dependent variables yielded no significant findings.

4.5 Mental state language in ToM and irony stories

Participants were awarded a point for each mental state term they used in their answers, and were also awarded 1, 2 or 3 points if they used a first, second or third order attribution respectively. This then gave a total mental state score for each participant on

each story type. Analyses of these variables using median split and correlational analyses revealed no significant relationships between schizotypy and use of mental state attributions.

5. Discussion

This study predicted that the performance on two tasks designed to measure ToM ability, the ToM/ physical stories task and understanding of irony stories task, would depend on participants' degree of schizotypy, as measured by the O-LIFE (Mason et al., 1995). Further predictions were made that scores on both tasks would be correlated, and that those schizotypal traits analogous to the behavioural signs of schizophrenia would be associated with the greatest impairment on the two tasks, followed by those traits analogous to the positive symptoms of schizophrenia, in line with Frith's (1992) theory.

These hypotheses were partially supported. Regression analysis showed that higher scores on the UE subscale of the O-LIFE predicted poorer understanding of irony, a finding that was reduced to a strong trend with the use of a conservative alpha to control for Type I error. However, the hypotheses were only supported from the results of the understanding of irony task, while scores on the ToM/ physical stories task were found by regression analyses to be predicted by IQ, and not schizotypy scores. The findings from the irony task will be discussed before those from the ToM/ physical stories.

5.1 Understanding of irony task

This study found that schizotypy was associated with performance on the irony task, in line with the study hypothesis. Langdon and Coltheart (2004) found that participants with high schizotypy, as measured by the Schizotypal Personality Questionnaire (SPQ: Raine, 1991), had greater difficulty understanding irony than those measured low in schizotypy. In the present study, total schizotypy scores measured by the O-LIFE were not found to be associated with scores on the irony stories. However, regression analysis

showed a strong trend for higher scores on the UE subscale of the O-LIFE to predict poorer understanding of irony, while the literal stories showed no such association.

Pickup (2006) used the O-LIFE to measure schizotypy, and also found that total scores were not associated with scores on his ToM task. He suggested that this could have been due to the use of the O-LIFE rather than the SPQ, which is based on the DSM criteria for schizotypal personality disorder and has a strong focus on schizotypal traits analogous to the positive symptoms of schizophrenia. Indeed, Pickup (2006) reported that about half of its total measured schizotypy is similar to the Unusual Experiences (UE) dimension of the O-LIFE. Therefore, the SPQ is closer to the UE subscale of the O-LIFE than it is to the O-LIFE as a whole, and this may account for both Pickup's (2006) findings and the findings reported here. In other words, the association that Langdon and Coltheart (2004) found between total SPQ scores and scores on their understanding of irony task may be the same association that this study found between the UE subscale of the O-LIFE and understanding of irony.

These similar results are in contrast to the results of studies that have investigated irony comprehension in individuals with schizophrenia. For example, poor understanding of irony has been associated with positive formal thought disorder (Langdon et al. 2002), while other studies have found that participants with schizophrenia in remission performed more poorly than controls (Herold, Tényi, Lénárd, & Trixler, 2002) or that those with schizophrenia showed no impairment in their understanding of irony (Drury, Robinson, & Birchwood, 1998). Mitchley et al. (1998), using the irony task that the present study adapted, found that poor irony comprehension was associated with

negative symptoms and not with positive ones. These mixed results could be due to the methodological issues discussed above, and further research is needed. Further investigation of the relationship between schizotypy and irony comprehension in non-clinical samples is also necessary in order to build on the results of this study and those of Langdon and Coltheart (2004). The finding that schizotypal traits analogous to positive symptoms may be more relevant to mental state understanding in non-clinical samples than those analogous to negative symptoms is discussed in more detail below.

5.2 ToM/ physical stories task

It was hypothesised that scores on the ToM stories task would also be associated with schizotypy. However, regression analysis revealed that instead of schizotypy, IQ was the only robust predictor of performance on this task, with both ToM and physical story performance being predicted by IQ.

Pickup (2006) used the same ToM/ physical stories task and reported a similar pattern of results to that found in the irony/literal stories task in the present study: scores on the UE subscale of the O-LIFE predicted scores on the ToM task, but not scores on the physical stories task. IQ was not found to be associated with scores on the ToM/physical stories task in Pickup's (2006) study. Therefore, the results of the present study appear to contradict those of Pickup (2006). However, a fundamental difference exists between this study and that of Pickup's: the mode of presentation of the stories. In Pickup, participants were permitted to re-read the stories as often as they wished before answering. Pickup (2006) hypothesised that this methodology prevented his participants from using their "on-line" ToM skills, and in an attempt to address this issue, in the

present study stories were presented once aurally to participants, who were then asked for a response. It was thought that this would maximise participants' reliance on their "on-line" ToM skills, and so would reveal a greater association between schizotypy and ToM task scores.

However, this methodology appears to have led to participants relying on their IQ-dependent problem solving skills to answer the ToM/ physical stories. Interestingly, this was not found to be the case for the irony/ literal stories, as IQ was not found to be associated with irony task performance. A reason for this could have been the differences between the two sets of stories. In the ToM/ physical task, the average length of each story was 95 words, while in the understanding of irony task the average length of each story was 30 words. As well as being three times longer on average, the ToM/ physical stories were more complicated (see appendices 4 and 5) with participants being required to hold more information in mind than in the irony/ literal stories. Because the ToM/ physical stories were longer and more complicated, it is possible that participants had to use IQ-dependent problem solving skills to answer the questions, instead of relying on their ToM skills. In the understanding of irony task, however, the shorter and simpler stories may have allowed participants to rely only on their ToM skills.

This has interesting implications for further research in this area because it reveals that a balance must be found between task difficulty and mode of presentation when considering task design in ToM studies. In other words, tasks must be designed to maximise reliance on "on-line" processing, but must not be so difficult as to encourage the use of IQ-dependent problem solving skills. It also shows the importance of controlling for IQ when carrying out research into ToM and schizotypy. Pickup (2006)

was the first person to include a measure of IQ in an investigation of ToM and schizotypy, and his analysis revealed no associations between IQ and ToM task scores. Studies with individuals with schizophrenia, however, have found such a link (Pickup and Frith, 2001), and it has been suggested that individuals with schizophrenia rely on their IQ-dependent problem solving skills because their ToM skills are impaired, while in non-clinical samples, ToM skills were presumed to be intact and so individuals in these samples were hypothesised not to need to use problem-solving skills (Corcoran et al., 1995). The results of this study, however, suggest that the picture is more complicated, and that non-clinical individuals' IQ-dependent skills may also take over when task difficulty reaches a certain level. It is possible that it is this threshold that changes across different populations. Individuals with schizophrenia may need to rely on their IQ skills at a lower level of task difficulty than individuals without schizophrenia, possibly because of their impaired ToM skills.

5.3 Symptom subgroup analysis

In line with Frith's (1992) theory, this study hypothesised that the greatest ToM impairments would be associated with schizotypal traits analogous to the "behavioural signs" of schizophrenia, followed by the schizotypal traits analogous to positive symptoms. This hypothesis was partially supported by the finding that UE subscale scores predicted performance on the irony task, but no association was found between traits analogous to behavioural signs and performance.

Following the methodology of Pickup (2006), this study attempted to allocate participants to subgroups based on Frith's (1992) model of schizophrenia, such that

those with only schizotypal traits analogous to the “behavioural signs” or “positive symptoms” of schizophrenia could be compared. However, this was not possible due to the small numbers of participants who demonstrated schizotypal traits analogous to “positive symptoms” in the absence of traits analogous to “behavioural signs”. This brings up an interesting methodological limitation of the study, namely the rigour of the sampling procedure used. Because the O-LIFE has four sub-scales, it would have been ideal to have been able to recruit participants who showed a range of scores on each subscale, rather than a range of total schizotypy scores. Further, it may have been possible to increase the chances of obtaining a wide range of scores on the UE subscale of the O-LIFE by targeting recruitment to populations that have been shown in previous studies to score highly on that subscale, for example members of New Religious Movements (e.g. Day and Peters, 1999). In this way, it may have been possible to ensure that there were sufficient numbers in each group to facilitate statistical analyses.

Langdon and Coltheart (1999) reported mixed results regarding the contribution of schizotypal traits analogous to behavioural signs. In their first experiment, participants with poorer ToM scores were more likely to rate items on the SPQ that related to interpersonal traits, analogous to negative behavioural signs, as well as cognitive-perceptual items, analogous to positive symptoms. In their second experiment, however, those with poor ToM scores were more likely to rate disorganised and cognitive-perceptual items.

Pickup (2006) found no association between ToM scores and schizotypal traits analogous to “behavioural signs”, and suggested that this may again have been related to

the mode of presentation of his stories. He hypothesised that the reduction of reliance on “on-line” processing skills could have reduced task sensitivity to the effects of the other dimensions of schizotypy. The findings of the present study cast doubt on this hypothesis, because traits analogous to “behavioural signs” were not found to be associated with scores on the irony task, which was presented in such a way as to maximise participants’ reliance on on-line processing.

Pickup (2006) also suggested that a difference may be emerging in ToM research between studies of schizotypy in a non-clinical sample and studies of individuals with schizophrenia. Many studies of individuals with schizophrenia have found clear associations between poor scores on ToM tasks and the presence of “behavioural signs” (e.g. Corcoran et al., 1995; Grieg et al., 2004; Sarfati et al., 1997), while a more mixed picture has been found for positive symptoms (e.g. Corcoran & Frith, 1996; Mazza et al., 2001). In the research with non-clinical samples to date, the predominant effect has been the association between poor ToM and schizotypal traits analogous to positive symptoms, such as the UE subscale of the O-LIFE (Pickup, 2006) or the cognitive-perceptual dimension of the SPQ (Langdon and Coltheart, 1999; 2004). The present study conformed to the hypothesis that non-clinical samples may be more likely to display associations between positive traits and poorer ToM skills. Pickup (2006) suggested that this may be due to the fact that these traits are the strongest index of psychosis-proneness in healthy individuals. Another reason for this finding may be related to the characteristics of the onset and course of schizophrenia. There is debate concerning the primacy of positive and negative symptoms of schizophrenia. As Andreasen, Roy and Flaum (1995) state, there is a recognition that some negative

symptoms may occur as a result of factors that are unrelated to underlying neural deficits, for example the side effects of neuroleptic medication, depression, a response to positive symptoms and environmental understimulation resulting from repeated or prolonged hospitalisation. Häfner et al. (1995) showed that on admission to hospital, positive symptoms tended to dominate the clinical picture, while six months on, negative symptoms tended to be more prominent. Further, Yung and McGorry (1996) found that the subjective experiences of prodromal and early psychotic signs clearly preceded the behavioural changes recognizable by the social environment. Therefore, it may be that positive symptoms in schizophrenia occur first, followed by the behavioural signs. It would be expected, therefore, that investigations with samples recruited from hospital wards would find a closer association between ToM performance and behavioural signs, especially negative behavioural signs, while studies of non-clinical samples would be more likely to find an association between ToM performance and traits analogous to positive symptoms.

5.4 ToM and Irony scores correlation

Despite the fact that scores on the ToM stories were associated with IQ and scores on the irony stories were associated with schizotypy, the two sets of scores were significantly correlated, as were the response times for both sets of stories. Therefore, those who scored highly and took less time on one set of stories also scored highly and took less time to answer the other set of stories, even though they may have been using different skills on each task. Unexpectedly, these correlations remained significant when IQ was controlled for. That a correlation between ToM and problem-solving ability independent of IQ was found implies that a third mechanism may have been influencing

both sets of scores. This could be due to the fact that both IQ-dependent problem solving and ToM share certain skills, for example holding information in mind and processing that information. This overlap in skills required for both sets of tasks could account for the association in task scores.

5.5 Executive function

As well as IQ, executive function was also controlled for using the Brixton test (Burgess & Shallice, 1997). This was important because previous studies have shown that high schizotypy is associated with poor executive function (e.g. Raine et al., 1992), and Russell (1998) proposed that individuals who scored poorly on ToM tasks did so because of a specific executive impairment in being “captured” by and responding to salient but irrelevant material. In their study of ToM and schizotypy, Langdon and Coltheart (1999) controlled for the effects of executive function through a task that they designed in which participants had to disregard salient but irrelevant information in order to sequence pictures correctly. In their study, Langdon and Coltheart (1999) found that the association between ToM and schizotypy was unrelated to executive function, as did Pickup (2006), who included the Cognitive Estimates Test (Shallice & Evans, 1978) in his study, although he did comment that this test may not have been sufficiently sensitive to detect difficulties with inhibition. The Brixton test (Burgess & Shallice, 1997) was included in the present study because it is sensitive to tendencies towards impulsive behaviour, which could underlie Russell’s (1998) hypothesis. Consistent with the findings of Langdon and Coltheart (1999) and Pickup (2006), no association was found between scores on the Brixton test and scores on either of the ToM tasks or

schizotypy measures. The results of these studies taken together, therefore, cast doubt on Russell's (1998) hypothesis.

5.6 Summary

This study provided evidence in partial support of Frith's (1992) cognitive neuropsychological model of schizophrenia. An association was found between schizotypy traits analogous to positive symptoms of schizophrenia and ToM performance measured by a task requiring the understanding of irony. No association was found between traits analogous to "behavioural signs" and ToM, contrary to Frith's (1992) theory. This study also highlighted the need for tasks to be developed that maximise reliance on "on-line" processing skills while not being so difficult that they encourage participants to rely on mainly IQ-dependent problem solving skills.

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Part 3: Critical appraisal

1. Introduction

This critical appraisal will discuss certain issues of particular interest to me that have come out of this research. Firstly, methodological limitations that have arisen from the study will be discussed, followed by the appeal of Frith's (1992) model and some observations about the schizotypy paradigm and its use in theory of mind (ToM) research. Then, clinical applications of Frith's theory will be discussed from a cognitive behavioural viewpoint in the main, but also from a family therapy perspective. Finally, some directions for future research will be detailed.

2. Methodological limitations

There are several methodological issues that this study has raised. Firstly, the mode of presentation of the stories to participants, and secondly issues arising from sampling. In the planning phase of the study, I had wanted to devise a way of presenting the ToM tasks to participants such that they were as "real-world" as possible. In other words, it was important to try to get away from the kinds of presentation in which participants could read the stories as many times as they wished, or were supplied with props, pictures and so on, and attempt to reproduce everyday communicative interactions as much as possible. This was because Pickup (2006) had hypothesised that his method of presentation (allowing participants to read the stories as often as they wished before answering) may have contributed to him not finding any association between schizotypal traits analogous to behavioural signs and ToM task performance. The methodology that I devised for this purpose was the recording of the stories on compact disc, and then the playing of the stories in a random order to participants, who were then asked to answer out loud.

Unfortunately, this methodology had unforeseen consequences. In the planning phase, I did not take into account the impact of the length and difficulty of the ToM/physical stories. This seems to have resulted in participants relying on their IQ-dependent problem solving skills rather than their ToM skills with these stories. Because the irony/literal stories are much shorter and less complicated, participants were able to use their ToM skills to answer these. Any future study using this methodology would benefit greatly from finding an alternative task to the ToM/physical stories, as it was not possible in this study to establish whether there was any meaningful correlation between irony and ToM tasks, or any association between ToM skills and schizotypy using this task and method of presentation.

Another interesting issue arising from the stories is the fact that participants found the physical and literal stories harder than the ToM and irony stories respectively. I suspect that this was due to different reasons in the different tasks. In the ToM/physical tasks, the physical stories are more abstract, and so it could have been more difficult for participants to hold all of the required information in their minds in order to give a correct response. In the literal stories, however, I believe that the stories were too simple, and that participants felt that the answer could not be so obvious. In the original presentation of the task (Mitchley et al., 1998), three possible answers were supplied with each story, and participants were asked to choose one of these answers. This would have given the participants the cue that, in fact, the experimenters were looking for the obvious answer. In the present study, however, the three possible answers were not supplied so that the story format remained as close as possible to the other task.

The second methodological issue is that of sampling. Participants were recruited through the UCL psychology department subject pool, and were screened for total schizotypy using the STA. This gave a large number of participants who were in the mid-schizotypy range, with only small numbers who were high or low. Further, very small numbers were high in the Unusual Experiences subscale of the O-LIFE and low in the other three scales, which meant that it was not possible to conduct reliable analyses with participants allocated to subgroups depending of schizotypy traits analogous to Frith's (1992) schizophrenia symptom classifications, which is disappointing.

If unlimited time and funds had been available to me, I would have recruited and screened participants differently. For example, it would have been very useful to screen participants using the O-LIFE, thus ensuring that there was a range of scores on each of the four subscales, as well as participants who were high in UE but low in the other three scales. Because the O-LIFE is a rather long questionnaire it would have been necessary to pay participants to fill it in, and then pay them again to complete the rest of the study. It would not be reasonable to ask participants to fill in the O-LIFE and then tell them that they were not needed for the rest of the study, and so would not be paid.

It would also have been possible to carry out targeted recruitment in order to specifically focus on populations that have been previously found to vary in schizotypy, such as members of New Religious Movements (Day & Peters, 1999) or those who are particularly creative or artistic (Claridge, 1997). Again, this might have increased the chances of getting a wider range of scores on the four scales.

3. Frith's cognitive neuropsychological model of schizophrenia

This study appealed to me because it was investigating Frith's (1992) theory of schizophrenia. Frith's theory is interesting because it takes a symptom-based view of schizophrenia, rather than treating schizophrenia as a single heterogeneous construct. In doing so, Frith departed from more traditional medical models of schizophrenia as a "brain disease" and generated an approach that seems more compatible with psychological approaches to treatment. As Boyle (2002) comments, there is little direct evidence to support the view that schizophrenia is a "brain disease", despite the strength of the belief that it is.

Although Frith took a symptom-based approach to schizophrenia, he combined it with more traditional cognitive and neuropsychological approaches, which aimed to account for patients' performance on certain psychological tasks. For example Callaway and Naghdi (1982) proposed their model of impaired controlled processing in schizophrenia to explain patients' poor performance on capacity-demanding tasks such as word recall, and Shallice, Burgess and Frith (1991) proposed executive function deficits following poor performance of individuals with schizophrenia on tasks sensitive to frontal lobe damage. The principle of developing a theory that can be tested experimentally through task performance is very useful, as it is amenable to evaluation, and by combining symptom- and task-based models Frith developed a model that was both intuitively plausible and open to experimental validation.

Frith's model is intuitively plausible because individuals with schizophrenia do often have autistic-like presentations. The flat affect, social withdrawal and other hallmark

negative symptoms of schizophrenia do resemble those of autism. Further, his account of the positive symptoms of schizophrenia as malfunctioning theory of mind is also persuasive. For example, it would be reasonable to think of paranoid symptoms as stemming from an impairment of the mechanism that regulates our relationships with the world and with other people. ToM is one such mechanism, as the understanding of an other's mental states is essential for the understanding of one's relationship with that person.

A second reason that Frith's theory is one that appears convincing is its inherent relation to another domain of schizophrenia theory: the role of the family. The family dynamics that are hypothesised to be contributory to the development of and relapse to schizophrenia (high 'expressed emotion': e.g. Butzlaff & Hooley, 1998) imply that dysfunctional interaction between people could be significant in schizophrenia's aetiology. Because a central theme of Frith's theory is impaired theory of mind (ToM), which has long been seen as a crucial tool in the navigation of the social world (Premack & Woodruff, 1978), his theory fits well with other schizophrenia models that highlight the importance of interactions between people.

Although Frith's theory seems to be open to experimental investigation due to the fact that it generates specific predictions that can be tested, a major difficulty with the validation of his theory stems from the fact that individuals with schizophrenia tend to present with several symptoms at the same time. For example, it is rare to find patients who exhibit behavioural signs in the absence of positive symptoms or passivity symptoms, as it is rare to find patients with only positive symptoms and no behavioural

signs. This means that individual symptom-based predictions are difficult to confirm, because the overlap in symptomatology makes it difficult to isolate individual symptoms and therefore test specific predictions. Studies using non-clinical samples, such as the present study, have tried to by-pass this difficulty using the schizotypy paradigm. However, this difficulty appears to occur in this population as well. In this study, there were very small numbers of people who were high in schizotypal traits analogous to positive symptoms and low in those traits analogous to behavioural signs. In a future study it would be useful to manage recruitment such that the performance on tasks of a subgroup of individuals who score highly on the UE subscale of the O-LIFE but not on the other subscales can be investigated. This was not possible in this study due to time and financial constraints.

4. Schizotypy

A dimension of the schizotypy paradigm that is interesting and has received little attention in the literature to date is the issue of whether low schizotypes really are more “normal” than high schizotypes. Studies that have investigated the schizotypy paradigm have tended to discuss a continuum of “psychosis-proneness” (Claridge, 1997) such that individuals high in schizotypy are considered akin to those with schizophrenia, while those with low schizotypy are considered “normal”. Studies seem to presume that a straight-line continuum exists from “normal” at one end to “psychotic” at the other, as evidenced by the use of correlational analyses such as regression, which assume a straight-line relationship. However, it is not obvious that this is the case. Loughland and Williams (1997) used cluster analysis to show that different clusters of individuals exist when the O-LIFE is administered to a non-psychiatric population. They called these

clusters: low schizotypy, introverted anhedonia, unusual experiences and cognitive disorganisation, based on the defining feature of each cluster. This study showed that there was a distinct subgroup of individuals who scored low in each of the four domains of the O-LIFE. Individuals who score low in schizotypy as measured by the O-LIFE may exhibit, very broadly, concrete thinking, be highly cognitively organised, unimpulsive and extroverted. While this pattern of personality traits is not akin to those associated with schizophrenia, it is perhaps not one that could be considered “normal” either. This implies that the psychosis continuum is not likely to be a straight line, but rather shaped such that those at either end would be considered “odd”, with “normality” being the exhibition of a mixture of schizotypal traits.

This has clear implications for studies that use the schizotypy paradigm. It does not seem enough to presume that low schizotypes are “normal” and therefore should be thought of in a similar way to a non-psychotic control group. Rather, low schizotypes should be investigated further in their own right. This has particular relevance to studies of ToM and schizotypy, as, although it has been found that low schizotypes perform better on ToM tasks than high schizotypes, it does not necessarily follow that they are using their ToM ability to carry out the tasks. For example, as detailed above, low schizotypes would be very cognitively organised so could be using problem solving skills, and would be un-impulsive, which could also give them an advantage over those with high schizotypy.

5. Clinical applications

The finding that ToM is impaired in people with schizophrenia has clear implications for psychological treatments. CBT and family interventions are the current recommended treatments for schizophrenia in the NHS following the publication of NICE guidelines in 2003 (NICE, 2003), and some of the implications of Frith's model for each treatment mode will be considered.

5.1 Cognitive Behaviour Therapy

Fowler, Garety and Kuipers (2000) describe the process of cognitive behaviour therapy for psychosis as a series of 6 stages: engagement and assessment, the implementation of cognitive behavioural coping strategies for psychotic symptoms, collaborative discussion of a new model of psychosis, cognitive therapy strategies for delusions, cognitive therapy for dysfunctional assumptions, and relapse prevention techniques.

A fundamental way in which Frith's theory can inform the practice of CBT is in providing therapists with an understanding of why it may be more difficult to engage clients with schizophrenia. It would be important for therapists to bear in mind that their expectations of relationship building may have to be altered for this client group, if individuals with schizophrenia find it difficult to infer the mental states of others. It may be that perceived resistance on the part of the client could be re-formulated in a more useful way as being part of the client's difficulties, and could be worked with in this way through the process of therapy. If a client with schizophrenia has difficulty with the attribution of mental states, it may be more difficult to come to a shared understanding with that client, and to therefore develop the connectedness that, I believe, is the basis for the deepening of the therapeutic relationship. At least, the therapist may have to

understand that the client finds this more difficult, and may therefore have to work harder to come to shared understandings.

A second area of CBT that Frith's model has relevance to is the collaborative discussion of a new model of psychosis. This is because the notion that a client has impairments in ToM is one that is explainable, and relatively easy to understand. Frith's model could be a useful framework within which to normalise the experience of the client, and to allow the client to develop a new position from which to view their difficulties. For example, explaining that humans have the ability to think about other people's thoughts and beliefs, and that this ability can go wrong, may give a client the opportunity to shift their thinking about their paranoid beliefs.

A third area of CBT that is relevant here is working with delusional beliefs. When working with delusional beliefs, Fowler et al. (2000) suggested that evidence for the belief should be elicited from the patient, as well as unwanted consequences of changing the belief. Then, alternative viewpoints and explanations should be generated in collaboration with the client with the aim of reducing distress. Frith's (1992) theory could be employed usefully as a framework within which alternative explanations for events are considered, for example by considering alternative mental states that a person may have held in a given situation. The rationale for this is that if a patient is distressed because they believe that someone else holds a negative intention or belief about them, then consideration of alternative mental states may reduce their paranoia and distress. This relies on the client having at least a partially intact ToM ability, and as Frith's theory proposes that patients with paranoid symptoms have an intact but malfunctioning

ToM, it should be possible to enter into a dialogue about mental states with clients with paranoid symptoms. Also, as studies have shown (e.g. Pickup & Frith, 2001), individuals with negative symptoms can retain 1st order ToM ability while their 2nd order abilities are impaired, and so they also may be able to enter into discussion about others' mental states, given that clinicians pitch their intervention at the right level. A question is raised concerning how this work could best be carried out. Through work with children with Autistic Spectrum Disorder, who are also hypothesised to have ToM deficits, protocols have been developed for teaching children ToM skills using pictorial representations, such as thought bubbles (e.g. Wellman et al., 2002). Individuals with schizophrenia also appear to have intact understanding of pictorial representation, irrespective of their ToM ability (Pickup & Frith, 2001), and so this is a technique that may be able to be usefully harnessed (Pickup, unpublished manuscript).

Another component of CBT that Frith's theory could contribute to is helping clients to improve their ToM skills in social situations. Although recent reviews have not found evidence that social skills training as a stand alone treatment is effective (e.g. Pilling et al., 2002), it has been argued that social skills training does play a role in CBT, for example through homework that takes the client into social situations in a graded way, and through the reality testing of delusions that involves interpreting the social behaviour of others. ToM-based social skills training has been investigated in a study carried out by Roncone et al. (2004), in which a small sample of 10 individuals with schizophrenia were given a social skills intervention consisting of six modules about topics including emotion recognition, communication of feelings, and managing common social situations. These patients showed an overall reduction in negative symptoms compared to a second group of 10 individuals with schizophrenia who

received supportive psychotherapy as a control intervention. Despite the fact that the samples involved in their study are small, this is an interesting finding that warrants further investigation.

5.2 Family therapy

The second recommended treatment for schizophrenia in the NICE guidelines is family therapy, or family interventions. These are based on the observation that high levels of criticism and emotional involvement (termed high 'expressed emotion', EE) are predictive of relapse to schizophrenia (e.g. Bebbington & Kruipers, 1994). Frith's theory is relevant here because ToM is widely thought of as essential for effective social interaction. The emotional environment within the family is likely to be affected by the degree to which family members are able to understand and infer each others' mental states. It is possible that the high levels of criticism and emotional involvement that are hallmarks of high EE could be due to, or at least influenced by, impairment in the ToM of family members, as well as the individual with schizophrenia. Janssen, Krabbendam, Jolles and van Os (2003) found that non-psychotic first-degree relatives were impaired on a ToM task compared to controls, with patients with schizophrenia performing worst of the three groups. This study shows that both patients with schizophrenia and their relatives display ToM difficulties. Therefore, family interventions may benefit from the introduction of social skills training specific to ToM, as detailed above. This would not be out of place in these interventions, as the NICE guidelines defined family interventions as containing an element of psychoeducation or problem solving work, into which ToM training could fit.

6. Future directions

This paper has identified various areas that would benefit from further investigation.

Firstly, it will be important to recruit specific samples of individuals in order that those who have isolated schizotypal traits can be compared. Secondly, it would be interesting to investigate those individuals who are low in schizotypy in order to begin to establish whether there is indeed a straight-line continuum for psychosis. Studies evaluating the inclusion of ToM training in CBT and family intervention for schizophrenia would also be helpful in delivering the most effective treatments to patients.

As this study showed, tasks that involve the understanding of irony appear to be sensitive enough to discriminate between the subtle ToM impairments associated with differing degrees of schizotypy. Further investigations of ToM and schizotypy would benefit from the use of such tasks. It would also be interesting to find out the nature of the ToM impairment, as well as its degree. For example, is the impairment such that individuals over-infer mental states, or do they have difficulty inferring any mental states at all? Frith (2004) uses the term over-mentalising, while Abu Akel and Bailey (2000) use the term hyper-ToM. If it is the case that high schizotypes and those with psychosis are over-inferring mental states, could this be related to information-processing styles? If so, this could have implications for other psychological disorders that are hypothesised to be linked to information processing, the most obvious example being Brewin's (2001) information processing account of post-traumatic stress disorder. Holmes and Steel (2004) showed that high schizotypy was associated with increased traumatic intrusions, and it is possible that the information processing styles that are more likely to lead to traumatic intrusions are similar to those that lead to or result from

ToM difficulties and psychosis. Further investigation of whether information processing styles differ according to schizotypy would be very interesting. Frith's (1992) model has been integrated into Garety, Kuipers, Fowler, Freeman and Bebbington's (2001) cognitive model of psychosis, in which it is argued that a triggering event gives rise in a predisposed person to a disruption of cognitive processes. One way in which this could happen, according to the model, is through difficulties with ToM. It would be interesting to investigate how Frith's theory could be integrated in other mainstream psychological models of other disorders, for example post-traumatic stress disorder.

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Appendix 1

Table of schizophrenia and ToM studies reviewed

Appendix 1:
Table of schizophrenia studies reviewed

Authors	Participants	Measures	Symptoms	Headline Results	Comments
1. Corcoran, Mercer & Frith (1995)	<ul style="list-style-type: none"> • 55 patients with schizophrenia • 30 healthy controls • 14 psychiatric controls (anxiety/depression) 	<ul style="list-style-type: none"> • Hinting task: all items read aloud, repeated if necessary • Quick test 	Hierarchical grouping method, symptoms assessed using PSE <ul style="list-style-type: none"> • Negative features (N=10) • Incoherence (N=3) • Paranoid (N=23) • Passivity (N=7) • Other symptoms (N=4) • Remission (N=8) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Negative features group scored worse than passivity, remission, controls • Paranoid and incoherent group worse than controls 	IQ covaried out: between group differences remained significant
2. Frith & Corcoran (1996)	<ul style="list-style-type: none"> • 55 patients with schizophrenia • 22 healthy controls • 13 psychiatric controls (anxiety/ depression) 	<ul style="list-style-type: none"> • 6 theory of mind stories: 1st and 2nd order false belief and deception read aloud with cartoon drawings 	Hierarchical grouping method, symptoms assessed using PSE <ul style="list-style-type: none"> • Behavioural signs (N=12) • Paranoid (N=24) • Passivity (N=10) • Remission (N=9) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Behavioural signs group and paranoid group performed poorly 	Matched for IQ Only significant findings for 2 nd order stories

3. Corcoran & Frith (1996)	<ul style="list-style-type: none"> • 49 patients with schizophrenia • 13 healthy controls • 10 psychiatric controls (anxiety/ depression) 	<ul style="list-style-type: none"> • Maxims test: stories read by participants, as often as required • Quick test 	<p>Hierarchical grouping method, symptoms assessed using PSE</p> <ul style="list-style-type: none"> • Negative behavioural signs (N=10) • Positive symptoms (N=17) • Passivity (N=11) • Remission and unusual symptoms (N=11) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Behavioural signs and passivity groups impaired on maxim of quantity • Behavioural signs impaired on maxim of quality • Paranoid group more likely to flout politeness rules 	<p>Paranoid politeness finding indicates “on-line” deficit</p>
4. Corcoran, Cahill & Frith (1997)	<ul style="list-style-type: none"> • 44 patients with schizophrenia • 40 healthy controls • 7 psychiatric controls (anxiety/depression) 	<ul style="list-style-type: none"> • Jokes task: 10 behavioural, 10 mental state. Participants shown jokes in picture form • Quick test 	<p>Hierarchical grouping method, symptoms assessed using PSE</p> <ul style="list-style-type: none"> • Behavioural signs (N=7) • Paranoid symptoms (N=16) • Passivity (N=8) • Remission and other symptoms (N=13) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Behavioural signs group worse than all other groups • Paranoid symptoms and passivity group worse than controls on mental state jokes 	

5. Pickup & Frith (2001)	<ul style="list-style-type: none"> • 41 patients with schizophrenia • 35 healthy controls • 18 psychiatric controls (anxiety/ depression) 	<ul style="list-style-type: none"> • 1st and 2nd order false belief stories, read aloud and enacted with Playmobil figures or other props • Corresponding non-mental representation tasks • Quick test 	<p>Hierarchical grouping method, symptoms assessed using PSE</p> <ul style="list-style-type: none"> • Behavioural signs (N=16) • Paranoid symptoms (N=16) • Passivity (N=1) • Remission (N=8) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • No differences found for 1st order tests • Behavioural signs group worst in 2nd order tests • Paranoid symptoms group showed trend to be worse than controls 	<p>Matched non-mental representation task indicates no difficulty with general representation</p>
6. Randall, Corcoran, Day & Bentall (2003)	<ul style="list-style-type: none"> • 18 patients with persecutory delusions. Schizophrenia and schizoaffective disorder • 14 remitted • 18 healthy controls 	<ul style="list-style-type: none"> • Digit span distraction task • ToM stories from Frith and Corcoran (1996) read aloud to participants, repeated on request • Internal, Personal and situational attributions questionnaire 	<p>Allocated to groups on basis of scores on PANSS</p>	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Paranoid delusions associated with ToM deficit • Abnormal attributions in paranoid group found only when rated independently • Remitted patients not sig. different to paranoid healthy control group 	<p>Did not use psychiatric control group</p>

7. Corcoran (2003)	<ul style="list-style-type: none"> • 39 patients with schizophrenia • 44 healthy controls 	<ul style="list-style-type: none"> • Hinting task, read aloud • Aha! Sentences task, read aloud • Quick Test • Story recall subtest from AMI • Means-ends problem solving task 	<p>Hierarchical grouping method, symptoms assessed using PSE</p> <ul style="list-style-type: none"> • No Behavioural signs • Delusions: persecutory (N=16); control (N=8) • Remission (N=15) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • In schizophrenia group, correlations found between scores on: Hinting task and Aha! Sentences; Hinting task and story recall; Aha! Sentences and IQ. These correlations not present in control group • Relationship between Hinting task and Aha! Sentences task weaker for remitted group 	<p>Individuals with schizophrenia rely on other cognitive abilities to perform Hinting task</p>
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8. Corcoran & Frith (2003)	<ul style="list-style-type: none"> • 59 patients with schizophrenia • 44 healthy controls 	<ul style="list-style-type: none"> • Hinting task, read aloud and left open for participants to read • ToM stories from Frith and Corcoran (1996), read aloud • Autobiographical incidents section of AMI • Quick test • Story recall from AMPIB 	<p>Hierarchical grouping method, symptoms assessed using PSE</p> <ul style="list-style-type: none"> • Negative behavioural signs (N=10) • Positive behavioural signs (N=10) • Paranoid symptoms (N=16) • Passivity (N=8) • Remission (N=15) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Hinting task correlated with ToM performance • Hinting task correlated with AMI score • ToM task correlated with AMI score 	No schizophrenia subgroup info given
9. Russell, Reynaud, Herba, Morris & Corcoran (2006)	<ul style="list-style-type: none"> • 61 patients with schizophrenia • 22 healthy controls 	<ul style="list-style-type: none"> • Animated sequences task • Quick test 	<p>Hierarchical grouping method, symptoms assessed using SAPS and SANS</p> <ul style="list-style-type: none"> • Behavioural signs (N=18); included positive (N=8) and negative (N=10) • Paranoid symptoms (N=15) • Passivity (N=15) • Remission (N=13) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Accuracy on task discriminated Behavioural signs and paranoid groups 	Behavioural signs and paranoid groups over-interpreting non-intentional movement

10. Sarfati, Hardy-Baylé, Besche & Widlocher (1997)	<ul style="list-style-type: none"> • 24 patients with schizophrenia • 12 psychiatric controls (depression) • 24 healthy controls 	<ul style="list-style-type: none"> • Attribution of Intention task: comic strip completion • Binois and Pichot vocab scale • PANSS 	<p>Grouped according to performance on TLC</p> <ul style="list-style-type: none"> • TLC score > 7: group with thought and speech disorganisation (N=12) • TLC score < 7: group without thought and speech disorganisation (N=12) <p>Also grouped according to DSM_III-R subtypes:</p> <ul style="list-style-type: none"> • Paranoid (N=7) • Residual (N=6) • Disorganised (N=5) • Undifferentiated (N=6) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • Group with TLC score > 7 performed more poorly than other three groups • No differences found when grouped according to DSM-III-R subtypes 	Consistent with Hardy-Baylé's (1994) action planning deficit hypothesis
11. Sarfati, Hardy-Baylé, Nadel, Chevalier, & Widlocher, (1997)	<ul style="list-style-type: none"> • 12 patients with schizophrenia • 12 psychiatric controls (depression) • 12 healthy controls 	<ul style="list-style-type: none"> • Attribution of Intention (AI) task: comic strip completion • False belief (FB) task: comic strip completion • SAPS & SANS 	<p>Grouped according to performance on TLC</p> <ul style="list-style-type: none"> • TLC score > 7: group with thought and speech disorganisation (N=6) • TLC score < 7: group without thought and speech disorganisation (N=6) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed most poorly overall • AI- High TLC scores sig. worse performance than controls and low TLC scores • FB- No differences between high, low TLC and controls 	<p>No IQ control</p> <p>FB- patients with schizophrenia performed worse than control groups</p>

12. Sarfati, Hardy-Baylé, Brunet, & Widlocher (1999)	<ul style="list-style-type: none"> • 26 patients with schizophrenia • 13 psychiatric controls (depression) • 13 healthy controls 	<ul style="list-style-type: none"> • Task from Sarfati et al (1997a) • Answer cards contained either pictures or short sentences • PANSS • Binois and Pichot vocab scale 	<p>Grouped according to performance on TLC</p> <ul style="list-style-type: none"> • TLC score > 7: group with thought and speech disorganisation (N=13) • TLC score < 7: group without thought and speech disorganisation (N=13) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worse in both pictorial and verbal conditions. • No differences between disorganisation groups 	<p>Participants presented same set of stories, once with pictorial answers and once with verbal answers, therefore high priming effect</p> <p>Global PANSS score sig. higher in high disorganisation group</p>
13. Sarfat & Hardy- Baylé (1999)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 10 psychiatric controls (manic) • 15 healthy controls 	<ul style="list-style-type: none"> • Comic strip completion with stories involving desire/ intention • PANSS • Binois and Pichot vocab scale 	<p>Grouped according to performance on TLC</p> <ul style="list-style-type: none"> • TLC score > 7: group with thought and speech disorganisation (N=15) • TLC score < 7: group without thought and speech disorganisation (N=10) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worse overall • Patients with disorganisation performed worse than those without and two controls • Patients with schizophrenia consistently chose answers depicting unambiguous and familiar situations 	<p>Global PANSS score sig. higher in high disorganisation group</p>

14. Sarfat, Passerieux, & Hardy- Baylé (2000)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 25 healthy controls 	<ul style="list-style-type: none"> • Replication of verbal/non-verbal comic strip conditions. • Participants did not complete same comic strips for each condition • PANSS • Binois and Pichot vocab scale 	<ul style="list-style-type: none"> • Patients grouped according to performance on task: good- 13 or 14 correct responses in pictorial and verbal sets; remediable- fewer than 13 correct in pictorial set, but 13 or 14 correct in verbal set; poor- fewer than 13 correct in both sets 	<ul style="list-style-type: none"> • Poor performers associated with duration of illness only • PANSS/ TLC scores not associated 	
15. Brunet, Safarti & Hardy- Baylé (2003)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 25 healthy controls 	<ul style="list-style-type: none"> • Comic strip completion, testing Attribution of Intention, Physical causality with characters, physical causality with objects • PANSS • Binois and Pichot vocab scale • TLC 	<ul style="list-style-type: none"> • Patients groups simply according to schizophrenia vs. control 	<ul style="list-style-type: none"> • Patients with schizophrenia impaired in Attribution of Intentions task, but not in either physical causality task 	No sub-grouping according to symptoms

16. Langdon, Michie, Ward, McConaghy, Catts & Coltheart (1997)	<ul style="list-style-type: none"> • 20 patients with schizophrenia • 20 healthy controls 	<ul style="list-style-type: none"> • Picture sequencing task: Mechanical/ social script/ pretence/ unrealised goal/ intention/ false belief • WAIS-R: block design and digits backwards 	<ul style="list-style-type: none"> • Patients grouped according to errors on stories • Subgroup 1: correctly ordered all stories (N=7) • Subgroup 2: only made errors on false belief stories (N=6) • Subgroup 3: general sequencing difficulty (N=7) • Patients grouped into Stuart et al (1995) factors and sub-factors using SAPS and SANS 	<ul style="list-style-type: none"> • Patients with schizophrenia worse on false belief stories • S3 patients had sig. higher ratings of reality distortion than S2 and S1 • S3 sig. higher ratings of negative symptoms than S2, who were sig. higher than S1
17. Langdon, Coltheart, Ward, & Catts (2001)	<ul style="list-style-type: none"> • 30 patients with schizophrenia, 2 with schizoaffective disorder • 24 Healthy controls 	<ul style="list-style-type: none"> • Picture sequencing task: Social script/ mechanical/ false belief/ capture stories • Visual memory span subtasks from WMS-R • Tower of London task 	<ul style="list-style-type: none"> • Patients grouped into Stuart et al (1995) factors and sub-factors using SAPS and SANS 	<ul style="list-style-type: none"> • Patients with schizophrenia showed impairments of disengagement and mentalising • Impairments in mentalising associated with negative symptoms, but not after exec function controlled for

18. Langdon, Davies & Coltheart (2002)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 20 healthy controls 	<ul style="list-style-type: none"> • Picture sequencing task: Social script/ mechanical/ false belief/ capture stories • Story comprehension task testing understanding of metaphor and irony • Spot the word test 	<ul style="list-style-type: none"> • Patients not put into subgroups according to symptoms 	<ul style="list-style-type: none"> • Patients made more errors than controls in false belief, capture and mechanical sequences • Patients sig more impaired in ability to recognise non-literal speech 	Metaphor and irony comprehension involve distinctive cognitive processes
19. Langdon, Coltheart, Ward & Catts (2002)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 20 healthy controls 	<ul style="list-style-type: none"> • Picture sequencing task: Social script/ mechanical/ false belief/ capture stories • Story comprehension task testing understanding of metaphor and irony • Spot the word test • Tower of London task 	<ul style="list-style-type: none"> • Patients divided into positive and negative formal thought disorder subgroups according to scores on SAPS and SANS 	<ul style="list-style-type: none"> • Patients performed more poorly than controls in all ToM tasks • Errors in false belief task predicted errors in irony task but not metaphor task • Poor understanding of metaphor predicted negative FTD • Poor understanding of irony predicted positive FTD 	

20. Harrington, Langdon, Siegert & McClure (2005)	<ul style="list-style-type: none"> • 25 patients with schizophrenia • 38 healthy controls 	<ul style="list-style-type: none"> • Verbal ToM task: cartoon pictures + words (FB and deception) • Non-verbal ToM task: picture sequencing (FB/mechanical/Social script/capture) • Block design and Vocab subtests from WAIS-R 	<ul style="list-style-type: none"> • Patients grouped into paranoid vs. non-paranoid groups based on SAPS persecutory delusions scores 	<ul style="list-style-type: none"> • Patients performed more poorly overall • Persecutory delusions predicted ToM task performance • Paranoid group performed more poorly on verbal rather than non-verbal tasks • Positive FTD also sig. correlated with ToM performance 	
21. Herold, Tenyi, Lenard & Trixler (2002)	<ul style="list-style-type: none"> • 20 patients with paranoid schizophrenia in remission • 20 healthy controls 	<ul style="list-style-type: none"> • 1st and 2nd order stories tasks from Doody et al. (1998) • 2 metaphor and irony stories tasks from Drury et al. (1998) 	<ul style="list-style-type: none"> • PANSS • Symptom subgroups not investigated 	<ul style="list-style-type: none"> • Schizophrenia patients worse on irony task, not on other tasks 	No IQ control
22. Tenyi, Herold, Szili & Trixler (2002)	<ul style="list-style-type: none"> • 26 patients with paranoid schizophrenia • 26 healthy controls 	<ul style="list-style-type: none"> • 4 question and answer vignettes testing maxim of relevance • WAIS • PANSS 	<ul style="list-style-type: none"> • No symptom subgrouping 	<ul style="list-style-type: none"> • Patients made more errors decoding the violated maxims than controls 	

23. Doody, Götz, Johnstone, Frith & Cunningham- Owens (1998)	<ul style="list-style-type: none"> • 28 patients with schizophrenia • 12 patients with affective disorder • 19 patients with mild learning disability • 18 patients with schizophrenia and mild learning disability • 20 healthy controls 	<ul style="list-style-type: none"> • NART • Quick Test • SADS-L • PANSS • Sally-Anne Task using dolls and props • Ice-cream van task using map and dolls 	<ul style="list-style-type: none"> • Symptoms studied using PANSS 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worst on tasks • Deficit in schizophrenia not entirely accounted for by IQ • Sig. association between negative symptoms and performance
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24. Drury, Robinson & Birchwood (1998)	<ul style="list-style-type: none"> • 14 patients with schizophrenia • 10 psychotic controls • 12 depressed controls 	<ul style="list-style-type: none"> • 3 2nd order false belief story tasks, read aloud twice plus props • substitution of co-referential term story task, read aloud plus props • metaphor sentence completion • irony and metaphor • picture completion subtest of WAIS-R • PAS 	<ul style="list-style-type: none"> • Participants re-tested on remission of illness • Grouped for comparison through diagnosis and Psychiatric Assessment Scale 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worst on tasks • All patients performed better on remission, apart from those with persecutory delusions • Deluded group performed as well as non-deluded gp during acute phase, but worse on remission • Patients with schizophrenia poorer on metaphor but not irony tasks 	IQ not related to performance
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25. Mitchley, Barber, Gray, Brooks & Livingston (1998)	<ul style="list-style-type: none"> • 18 patients with chronic schizophrenia • 13 non-psychotic psychiatric controls 	<ul style="list-style-type: none"> • Comprehension of irony task, read by participants • Raven's progressive matrices • NART 	<ul style="list-style-type: none"> • PANSS rating used, participants not divided into groups 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worse on irony task • Performance not related to current or pre-morbid IQ • Negative, and not positive or general, PANSS scale correlated with irony scores 	
26. Walston, Blennerhassett & Charlton (2000)	<ul style="list-style-type: none"> • 4 patients with "pure" persecutory delusions and no other psychopathology 	<ul style="list-style-type: none"> • ToM tests: Humorous cartoons, written narratives, hinting task 	<ul style="list-style-type: none"> • Case study design 	<ul style="list-style-type: none"> • All 4 cases performed at near perfect levels on all ToM tasks 	<p>Not intended to be representative population sample</p> <p>Does not imply that all patients with persecutory delusions have impaired ToM due to design</p>

27. Mazza, De Risio, Surian, Roncone & Casacchia (2001)	<ul style="list-style-type: none"> • 35 patients with schizophrenia • 17 healthy controls 	<ul style="list-style-type: none"> • 4 1st and 2nd order false belief stories, read aloud • Verbal memory test • Verbal fluency test • Tower of London test • Wisconsin card sorting test 	<ul style="list-style-type: none"> • Patients assessed using SAPS and SANS: divided into 3 groups according to Liddle's (1987) model- reality distortion (N=8), psychomotor poverty (N=16), disorganisation (N=16) 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worse on ToM stories than controls • Psychomotor poverty group worse than other two groups 	Groups matched on IQ and Exec function
28. Pollice, Roncone, Falloon, Mazza, De Risio, Necozone, Morosini & Casacchia (2002)	<ul style="list-style-type: none"> • 44 patients with schizophrenia 	<ul style="list-style-type: none"> • 4 1st & 2nd order ToM stories, read aloud • Raven's standard progressive matrices • Verbal memory test • Verbal Fluency test • Tower of London test • WCST 	<ul style="list-style-type: none"> • Brief psychiatric rating scale- no symptom subgroups • Disability assessment schedule 	<ul style="list-style-type: none"> • No healthy control group • Symptom ratings did not correlate with ToM scores 	

29. Janssen, Krabbendam, Jolles & van Os (2003)	<ul style="list-style-type: none"> • 43 psychotic patients in remission • 41 non-psychotic 1st degree relatives • 43 healthy controls 	<ul style="list-style-type: none"> • False belief story task, read aloud • Hinting task • Digit span backwards • Auditory verbal learning task • Animal naming • Stroop colour word test • Concept shifting test • Groningen Intelligence test • BPRS • PANSS • PDI 	<ul style="list-style-type: none"> • No symptom subgrouping 	<ul style="list-style-type: none"> • Patients in remission performed worst on hinting task, followed by relatives, followed by controls • Patients in remission also worse on FB task, but not sig. 	Only 1 st order FB task used, no 2 nd order or above
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30. Greig, Bryson & Bell (2004)	<ul style="list-style-type: none"> • 128 patients with schizophrenia or schizoaffective disorder 	<ul style="list-style-type: none"> • Hinting task • Gorham's proverbs • SCID • Continuous performance task • Hopkins' verbal learning test • Trail making • WAIS-R • WCST 	<ul style="list-style-type: none"> • Symptoms assessed using PANSS and SAPS 	<ul style="list-style-type: none"> • Patients with disorganized schizophrenia performed most poorly • ToM performance correlated with thought disorder • ToM performance related to PANSS delusion items, PANSS negative component, PANSS positive component • No correlation between ToM performance and SAPS persecutory delusions items • ToM performance related to memory and verbal memory
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31. Kelemen, Keri, Must, Benedek & Janka (2004)	<ul style="list-style-type: none"> • 79 first degree biological relatives of schizophrenia patients: 65 unaffected relatives; 14 affected relatives • 40 healthy controls 	<ul style="list-style-type: none"> • Eyes test • WAIS-R • Mini-international neuropsychiatric interview plus 	<ul style="list-style-type: none"> • No symptom subgrouping 	<ul style="list-style-type: none"> • Affected relatives performed worse than unaffected and healthy controls 	Evidence for state rather than trait model
32. Brune (2005)	<ul style="list-style-type: none"> • 23 patients with schizophrenia • 18 healthy controls 	<ul style="list-style-type: none"> • Pictures of Facial Affect • 6 cartoon picture sequencing stories • ToM questionnaire referring to picture sequencing task • Verbal IQ-MWT test • Executive function-computerized WCST; 2 subtests from BADS 	<ul style="list-style-type: none"> • Symptoms assessed using PANSS • Social functioning assessed using SBS 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worse on exec function tests, emotion recognition test (apart from 'reciprocity' and 'happiness') and 2nd order ToM task • PANSS scores not correlated with ToM scores 	When IQ and executive function controlled for, patients remained poorer at emotion recognition and ToM tasks

33. Brune & Bodenstein (2005)	<ul style="list-style-type: none"> • 31 patients with schizophrenia • 21 healthy controls 	<ul style="list-style-type: none"> • proverbs test • picture sequencing • ToM questionnaire • MWT • Spot the word test • WCST • Zoo map test 	<ul style="list-style-type: none"> • Symptoms assessed using PANSS 	<ul style="list-style-type: none"> • Patients performed worse on ToM tests • Proverbs score correlated with picture sequencing score • No association between proverb score/ picture sequencing score and PANSS scores 	
34. Majoram, Miller, Lawrie, Johnstone, Gardiner, & Burns (2005)	<ul style="list-style-type: none"> • 15 patients with schizophrenia • 15 psychiatric controls (bipolar disorder, n=7, and depression, n=8) • 15 healthy controls 	<ul style="list-style-type: none"> • extended hinting task, with 10 new items • Quick test 	<ul style="list-style-type: none"> • All patients divided into groups according to Krawiecka et al (1977) standardized scale for rating chronic psychotic patients • None/low or moderate/severe delusions • None/low or moderate/severe hallucinations 	<ul style="list-style-type: none"> • Patients with schizophrenia performed worst on hinting task • Poor performance sig. associated with moderate/severe delusions and hallucinations • No sig. association between performance and negative symptoms 	<p>1st study to show similar impairment in other patient groups with psychosis, i.e. bipolar group</p>

Appendix 2

Schizotypal Personality Scale (STA; Claridge & Broks, 1984)

RESEARCH PROJECT for DOCTORATE IN CLINICAL PSYCHOLOGY

SCHIZOTYPY, THEORY OF MIND AND THE UNDERSTANDING OF IRONY

Do you believe in telepathy?	Y	N
Do you often feel that other people have it in for you?	Y	N
When in the dark do you see shapes and forms even though there's nothing there?	Y	N
If you say you will do something, do you always keep your promise no matter how inconvenient it might be?	Y	N
Does your own voice ever seem distant, far away?	Y	N
Does it often happen that almost every thought immediately and automatically suggests an enormous number of ideas?	Y	N
Do you ever become oversensitive to light or noise?	Y	N
Were you ever greedy by helping yourself to more than your share of anything?	Y	N
Do you often have vivid dreams that disturb your sleep?	Y	N
When you are worried or anxious do you have trouble with your bowels?	Y	N
Have you ever felt when you looked in the mirror that your face seemed different?	Y	N
Have you ever blamed someone for doing something you knew was really your fault?	Y	N
Do you feel it is safer to trust nobody?	Y	N
Do things sometimes feel as if they were not real?	Y	N
Do you feel lonely most of the time even when you are with people?	Y	N
Are <i>all</i> your habits good and desirable ones?	Y	N
Do everyday things sometimes seem unusually large or small?	Y	N
Are you often bothered by the feeling that people are watching you?	Y	N
Do you feel that you cannot get 'close' to other people?	Y	N
Have you ever taken anything (even a pin or button) that belonged to someone else?	Y	N
Do you dread going into a room by yourself where other people are already gathered and talking?	Y	N

Does your sense of smell sometimes become unusually strong?	Y	N
Are you sometimes sure that other people can tell what you are thinking?	Y	N
Have you ever broken or lost something that belongs to someone else?	Y	N
Have you ever had the sensation of your body or part of it changing shape?	Y	N
Do you ever feel sure that something is about to happen even though there doesn't seem to be any reason for you thinking that?	Y	N
Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?	Y	N
Have you ever said anything bad or nasty about anyone?	Y	N
Do you ever have a vague sense of danger or sudden dread for reasons that you do not understand?	Y	N
Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?	Y	N
Do your thoughts ever stop suddenly causing you to interrupt what you're doing?	Y	N
As a child were you ever cheeky to your parents?	Y	N
Do you feel that you have to be on your guard even with your friends?	Y	N
Do you ever feel that your thoughts don't belong to you?	Y	N
When in a crowded room do you often have difficulty in following a conversation?	Y	N
Have you ever cheated at a game?	Y	N
Do you sometimes feel that your accidents are caused by mysterious forces?	Y	N
Do you feel at times that people are talking about you?	Y	N
Do you believe that dreams can come true?	Y	N
Have you ever taken advantage of someone?	Y	N
Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?	Y	N
Are your thoughts sometimes so strong that you can almost hear them?	Y	N
When coming into a new situation have you ever felt strongly that it was a repeat of something that has happened before?	Y	N
Do you always practice what you preach?	Y	N

Have you ever felt that you were communicating with another person telepathically?	Y	N
Are you easily distracted from work by daydreams?	Y	N
Are you very hurt by criticism?	Y	N
Do you sometimes put off until tomorrow what you ought to do today?	Y	N
Do you ever get nervous when someone is walking behind you?	Y	N

Appendix 3

The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason et al., 1995)

RESEARCH PROJECT for DOCTORATE IN CLINICAL PSYCHOLOGY

SCHIZOTYPY, THEORY OF MIND AND THE UNDERSTANDING OF IRONY

Do you often have a day when indoor lights seem so bright they bother your eyes?	Y	N
Do you frequently have difficulty in starting to do things?	Y	N
Do you enjoy many different kinds of play and recreation?	Y	N
Do you consider yourself to be pretty much an average kind of person?	Y	N
Are the sounds you hear in your daydreams usually clear and distinct?	Y	N
Do you often hesitate when you are going to say something in a group of people that you know more or less?	Y	N
Have you had very little fun from physical activities like walking, swimming or sports?	Y	N
Do you often overindulge in alcohol or food?	Y	N
Are your thoughts sometimes as real as actual events in your life?	Y	N
Do you often worry about things you should not have done or said?	Y	N
Has dancing, or the idea of it, always seemed dull to you?	Y	N
When with groups of people, do you usually prefer to let someone else be the centre of attention?	Y	N
Does it often happen that nearly every thought immediately and automatically suggests an enormous number of ideas?	Y	N
When in a crowded room, do you often have difficulty following the conversation?	Y	N
Is trying new foods something you have always enjoyed?	Y	N
When you catch a train do you often arrive at the last minute?	Y	N
Are your thoughts sometimes so strong you can almost hear them?	Y	N
No matter how hard you try to concentrate, do unrelated thoughts always creep into your mind?	Y	N
Are there very few things that you have ever really enjoyed doing?	Y	N

Do you often change between intense liking and disliking of the same person?	Y	N
Do you think you could learn to read others' minds if you wanted to?	Y	N
Are you easily hurt when people find fault with you or the work you do?	Y	N
Are you much too independent to really get on with other people?	Y	N
Have you ever cheated at a game?	Y	N
Have you felt that you have special, almost magical powers?	Y	N
Do you easily lose courage when you are criticised or failing in something?	Y	N
Do you think having close friends is not as important as some people say?	Y	N
Do you at times have an urge to do something harmful or shocking?	Y	N
Do ideas and insights sometimes come to you so fast that you cannot express them all?	Y	N
Do you seem to be a person whose mood goes up and down easily?	Y	N
Are you rather lively?	Y	N
Are you usually in an average sort of mood, not too high and not too low?	Y	N
Can some people make you aware of them just by thinking about you?	Y	N
Are you sometimes so nervous that you are 'blocked'?	Y	N
Does it often feel good to massage your muscles when they are tired or sore?	Y	N
Would you take drugs which may have strange or dangerous effects?	Y	N
Does a passing thought sometimes seem so real that it frightens you?	Y	N
Do you find it difficult to keep interested in the same thing for a long time?	Y	N
Do you like mixing with people?	Y	N
Do you stop to think things over before doing anything?	Y	N
Does your voice ever seem distant, faraway?	Y	N
Do you dread going into a room by yourself where other people have already gathered and are talking?	Y	N
On seeing a soft, thick carpet have you sometimes had the impulse to take your shoes off and walk barefoot on it?	Y	N

Have you ever blamed someone for doing something you know was really your fault?	Y	N
Do you sometimes feel that your accidents are caused by mysterious forces?	Y	N
Do you often have difficulties in controlling your thoughts when you are thinking?	Y	N
Are people usually better off if they stay aloof from emotional involvements with most others?	Y	N
Would being in debt worry you?	Y	N
Do people in your daydreams seem so true to life that you sometimes think they are?	Y	N
Do you often feel that there is no purpose to life?	Y	N
Can just being friends make you feel really good?	Y	N
Do you think people spend too much time safeguarding their future with savings and insurance?	Y	N
Is your hearing sometimes so sensitive that ordinary sounds become uncomfortable?	Y	N
Do you worry about awful things that might happen to you?	Y	N
Have you often felt uncomfortable when your friends touch you?	Y	N
Do you ever have the urge to break or smash things?	Y	N
Have you ever felt that you might cause something to happen just by thinking too much about it?	Y	N
Are you easily distracted from work by daydreams?	Y	N
When things are bothering you, do you like to talk to other people about it?	Y	N
Have you ever felt the urge to injure yourself?	Y	N
Are you so good at controlling others that it sometimes scares you?	Y	N
Are you easily confused if too much happens at the same time?	Y	N
Do you have many friends?	Y	N
Would it make you nervous to play the clown in front of other people?	Y	N
Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?	Y	N
Do you worry too long after an embarrassing experience?	Y	N

Do you prefer watching television to going out with other people?	Y	N
Have you ever taken advantage of someone?	Y	N
Have you sometimes had the feeling of gaining or losing energy when certain people look at you or touch you?	Y	N
Do you often feel lonely?	Y	N
Is it true that your relationships with other people never get very intense?	Y	N
Would you like other people to be afraid of you?	Y	N
Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?	Y	N
Do you often experience an overwhelming sense of emptiness?	Y	N
Do you love having your back massaged?	Y	N
Do you often have an urge to hit someone?	Y	N
Have you occasionally felt as if your body did not exist?	Y	N
Do you often feel 'fed up'?	Y	N
Is it fun to sing with other people?	Y	N
Do people who drive carefully annoy you?	Y	N
On occasions, have you seen a person's face in front of you when no one was in fact there?	Y	N
Would you call yourself a nervous person?	Y	N
Do people who try to get to know you usually give up after a while?	Y	N
Do you sometimes talk about things you know nothing about?	Y	N
Have you ever wondered whether the spirits of the dead can influence the living?	Y	N
Is it hard for you to make decisions?	Y	N
Can you usually let yourself go and enjoy yourself at a lively party?	Y	N
Do you often feel like doing the opposite of what other people suggest, even though you know they are right?	Y	N
Have you ever felt as though your head or limbs were somehow not your own?	Y	N

Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?	Y	N
Are the bright lights of a city exciting to look at?	Y	N
Do you often feel the impulse to spend money which you know you can't afford?	Y	N
Now and then when you look in the mirror, does your face seem quite different than usual?	Y	N
Are you easily distracted when you read or talk to someone?	Y	N
Do you usually have very little desire to buy new kinds of foods?	Y	N
Do you like going out a lot?	Y	N
Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?	Y	N
Do you feel very close to your friends?	Y	N
When in the dark, do you often see shapes and forms even though there's nothing there?	Y	N
Do you feel that making new friends isn't worth the energy it takes?	Y	N
Have you sometimes sensed an evil presence around you, although you could not see it?	Y	N
Does your sense of smell sometimes become unusually strong?	Y	N
Do you ever feel sure that something is about to happen, even though there does not seem to be any reason for you thinking that?	Y	N

Appendix 4

Theory of mind stories task

Theory of Mind Task

Theory of Mind and physical control stories from Pickup (2006)

Practice story

On Christmas Eve, Alice's mother takes her to the big department store in town. They go to look in the toy department. In the toy department Mr Brown, Alice's next door neighbour, is dressed up as Santa Claus, giving out sweets to all the children. Alice thinks she recognises Mr Brown, so she runs up to him and asks, "Who are you?" Mr Brown answers, "I'm Santa Claus!"

Q: Why does he say this?

1.

Simon is a big liar. Simon's brother Jim knows this; he knows that Simon never tells the truth! Now yesterday Simon stole Jim's ping-pong paddle, and Jim knows Simon has hidden it somewhere, though he can't find it. He's very cross. So he finds Simon and he says, "Where is my ping-pong paddle? You must have hidden it either in the cupboard or under your bed, because I've looked everywhere else. Where is it, in the cupboard or under your bed?" Simon tells him the paddle is under his bed.

Q: Why will Jim look in the cupboard for the paddle?

2.

During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever; he will not let them find his tanks. The tanks are really in the mountains. Now when the other side ask him where his tanks are, he says, "They are in the mountains".

Q: Why did the prisoner say that?

3.

Brian is always hungry. Today at school it is his favourite meal - sausages and beans. He is a very greedy boy, and he would like to have more sausages than anybody else, even though his mother will have made him a lovely meal when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, "Oh, please can I have four sausages, because I won't be having any dinner when I get home!"

Q: Why does Brian say this?

4.

Jill wanted to buy a kitten, so she went to see Mrs. Smith, who had lots of kittens she didn't want. Now Mrs. Smith loved the kittens, and she wouldn't do anything to harm them, though she couldn't keep them all herself. When Jill visited she wasn't sure she wanted one of Mrs. Smith's kittens, since they were all males and she had wanted a female. But Mrs. Smith said, "If no one buys the kittens I'll just have to drown them!"

Q: Why did Mrs. Smith say that?

5.

One day Aunt Jane came to visit Peter. Now Peter loves his aunt very much, but today she is wearing a new hat; a new hat which Peter thinks is very ugly indeed. Peter thinks his aunt looks silly in it and much nicer in her old hat. But when Aunt Jane asks Peter, "How do you like my new hat?", Peter says, "Oh, its very nice".

Q: Why does he say that?

6.

Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than

anything in the world. At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage. But when she opened it, with all the family standing round, she found her present was just a boring old set of encyclopaedias, which Helen did not want at all! Still, when Helen's parents asked her how she liked her Christmas present, she said, "It's lovely, thank you. It's just what I wanted".

Q: Why did she say this?

7.

Late one night old Mrs. Peabody is walking home. She doesn't like walking home alone in the dark because she is always afraid that someone will attack her and rob her. She really is a very nervous person! Suddenly, out of the shadows comes a man. He wants to ask Mrs. Peabody what time it is, so he walks towards her. When Mrs. Peabody sees the man coming towards her, she starts to tremble and says, "Take my purse, just don't hurt me please!"

Q: Why did she say that?

8.

A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar; he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey, you! Stop!", the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Q: Why did the burglar do that?

9.

Two enemy powers have been at war for a very long time. Each army has won several battles, but now the outcome could go either way. The forces are equally matched. However, the Blue army is stronger than the Yellow army in foot soldiers and artillery. But the Yellow army is stronger than the Blue Army in air power. On the day of the final battle, which will decide the outcome of the war, there is heavy fog over the mountains where the fighting is about to occur. Low-lying clouds hang above the soldiers. By the end of the day the Blue army has won.

Q: Why did the Blue army win?

10.

A burglar is about to break into a jewellers' shop. He skilfully picks the lock on the shop door. Carefully he crawls under the electronic detector beam. If he breaks this beam it will set off the alarm. Quietly he opens the door of the store-room and sees the gems glittering. As he reaches out, however, he steps on something soft. He hears a screech and something small and furry runs out past him, towards the shop door. Immediately the alarm sounds.

Q: Why did the alarm go off?

11.

Mrs. Simpson, the librarian, receives a special book which she has to catalogue and find an appropriate place for. She has to decide which section to file it under. The library is very big, and has different sections on many different subjects. The new book is about plants and their medical uses, and is heavily illustrated. However, Mrs. Simpson does not put it on the shelf with the rest of the books on botany. Neither does she put it with the books on medicine. Instead, she carefully takes it into a separate room. In this room all the books are kept in special cases and the temperature is kept constant.

Q: Why did she do this?

12.

Henry is preparing for a big dinner party. He is famous for his excellent mayonnaise. He has bought lots of fresh eggs. The recipe says, "Carefully separate the yolks of six eggs and add oil very gradually". He has already bought easily enough dessert to feed everyone. However, he now looks up the recipe for meringues. Henry will not waste anything.

Q: Why does Henry make meringues?

13.

Paul is very rich, and today he is going to buy an expensive new car. He is considering whether to make a single payment, or whether to spread the cost over the year. If he pays in monthly instalments, the dealer will charge five percent interest on the loan. His bank currently gives him eight percent interest on the money in his account. Even though he has easily enough money to pay the full amount, he decides to pay by monthly instalments.

Q: Why does he do that?

14.

Old Mrs. Robinson is very frail. One day she slips on her icy door step and falls on her side. She gets up right away, although she feels quite bruised and shaken. The next day her leg feels very stiff and she can scarcely walk. She makes her way to the doctors. As soon as the doctor hears about the fall, and sees her swollen side, he says, "Go immediately to the hospital". At the hospital they take an X-ray.

Q: Why did they take an X-ray?

15.

Sarah is very far-sighted. She has only one pair of glasses, which she keeps losing. Today she has lost her glasses again and she needs to find them. She had them yesterday evening when she looked up the television programs. She must have left them somewhere that she has been today. She asks Ted to find her glasses. She tells him that today she went to her regular early morning exercise class, then to the post office, and last to the flower shop. Ted goes straight to the post office.

Q: Why is the post office the most likely place to look?

16.

John is going shopping. He buys a nice new desk lamp, for his study. He needs a light bulb for his new lamp. He goes from the furniture department to the electrical department. In the electrical department he finds that there are two brands of light bulb of the right kind. Everbrite light bulbs cost less in single packs than Literite bulbs. However, only Literite bulbs come in multi-packs of six. John buys the multi-pack, even though he only needs one bulb.

Q: Why does John buy the Literite bulbs?

Appendix 5

Understanding of irony stories task

Understanding of Irony task
Irony Stories taken Mitchley et al. (1998)

1.

Lisa couldn't go to school because of the snow. "What a pity!" she said, smiling. "I'll miss my maths test."

What did Lisa mean?

2.

Tanya looked round her brother Gareth's flat: there were no signs of last night's party. "I see you've tidied up" she said.

What did Tanya mean?

3.

Chris's three goals secured a victory for his team on Saturday. After the game, Kevin congratulated him: "You've played well today, Chris."

What does Kevin mean?

4.

Andy and Darryl walked out of the cinema after only half an hour. "Well that was a great film," said Andy.

What did Andy mean?

5.

Mary's boss would not give her time off to visit her granny in hospital. As she left her boss' office, Mary said angrily, "Thanks for being so understanding."

What did Mary mean?

6.

When Bill and Steve entered the pub, they found it was so busy they had difficulty getting to the bar. Bill remarked, “it’s really lively in here tonight.”

What did Bill mean?

7.

Fred looked at his race card; none of his horses had even been placed. “Another successful day,” he sighed.

What did Fred mean?

8.

“What a tidy piece of work,” said that teacher, handing back Claire’s perfectly typewritten homework.

What did the teacher mean?

9.

Robbie had just finished his third helping of pie, and was asking his mother if there was any more. “What a dainty appetite you have, Robbie,” replied his mother.

What did Robbie’s mother mean?

10.

Although it was the first time he had been skating, Mike had no problem balancing on the ice and was soon confident enough to skate backwards. “I’ve got a natural talent for skating,” said Mike.

What did Mike mean?

11.

Sitting down to his tea Mr Jones exclaimed, “what an enormous meal!” “You don’t have to eat it all,” replied his wife.

What did Mr Jones mean?

12.

As they left the pub, Richard said “that was sensitive of you, Tom”. “How was I to know Mark had just split up with his girlfriend?” protested Tom.

What did Richard mean?

13.

Karen and Jane were out on a Sunday afternoon drive. “What a lovely day,” said Karen. “We’ve been lucky with the weather,” replied Jane.

What did Karen mean?

14.

As Sarah arrived, John looked at his watch and said, “punctual as ever.” “Sorry, I had to wait ages for the bus,” replied Sarah.

What did John mean?

15.

Mr Wilson was putting up shelves in the living room. “What a professional job!” exclaimed his wife when she came to see how he was getting on. “Well it’s easy when you know how,” replied Mr Wilson, proudly.

What did Mrs Wilson mean?

16.

“Have we been burgled?” said Jack, walking into the bedroom. “Sorry about the mess, I was just cleaning out some old clothes,” replied his wife.

What did Jack mean?

17.

“I didn’t know it was supposed to be fancy dress tonight,” said Mr Harris, as he saw what his daughter Anne was wearing for the party. “Very funny, Dad,” replied Anne. “You haven’t got a clue about fashion.”

What did Mr Harris mean?

18.

“I can see you put a lot of work into the garden,” said Paul. “Yes, well I’m hoping to enter the local gardening competition,” replied Jim.

What did Paul mean?

Appendix 6

Participant information sheet and consent form

INFORMATION SHEET FOR VOLUNTEERS

Study Title: Schizotypy, theory of mind and the understanding of irony: an investigation

Investigators: Ben Barnaby, Department of Clinical Health Psychology,
UCL, Gower Street, London WC1E 6BT

Dr G. Pickup, Department of Clinical Health Psychology,
UCL, Gower Street, London WC1E 6BT

You are invited to participate in a research project which investigates the relationship between certain personality traits and the ability to work out what other people think in particular situations. As a healthy volunteer, the data you provide will give us information about the normal variation in people's understanding of social situations.

You will be asked to complete a brief screening questionnaire. On the basis of this you may then be asked to participate in the study. This would entail completing one more questionnaire, answering questions on some stories and completing two short tests of intelligence and reasoning ability. This interview takes approximately one hour in total. Your answers to all these questions will be completely confidential and identified only by a number rather than by your name. You will receive £10 for taking part, which is a 'thank you' gesture from us.

There are no potential risks involved in the research.

You do not have to take part in this study if you do not want to. If you decide to take part you may withdraw at any time without having to give a reason.

All proposals for research using human subjects are reviewed by an ethics committee before they can proceed. This proposal was reviewed by the UCL Committee on the Ethics of Human Research.

Please feel free to ask any questions about the research, and we will do our best to answer them.

CONFIDENTIAL

CONSENT FORM FOR VOLUNTEERS

Study Title: Schizotypy, theory of mind and the understanding of irony: an investigation

Investigators: Ben Barnaby, Department of Clinical Health Psychology,
UCL, Gower Street, London WC1E 6BT

Dr G. Pickup, Department of Clinical Health Psychology,
UCL, Gower Street, London WC1E 6BT
Tel:

	Yes	No
Have you read the Participant Information sheet?		
Has the project been explained to you orally?		
Have you had the opportunity to ask questions and discuss the study?		
Have you received satisfactory answers to all your questions?		
Have you received enough information about the study? Who have you spoken to?.....		
Do you understand that you are free to withdraw from the study without penalty at any stage?		
Do you agree with the publication of the results of this study in an appropriate outlet/s?		

Comment or Concerns During the Study

If you have any comments or concerns you should discuss these with the Principal Researcher. If you wish to go further and complain about any aspect of the way you have been approached or treated during the course of the study, you should email the Chair of the UCL Committee for the Ethics of Non-NHS Human Research (gradschoolhead@ucl.ac.uk) or send a letter to: The Graduate School, North Cloisters, Wilkins Building, UCL, Gower Street, London WC1E 6BT who will take the complaint forward as necessary.

Signed:..... Date.....

Full Name in Capitals:.....

Signature of Witness:..... Date.....

Full Name in Capitals:.....

Appendix 7

Ethical approval conformation letter



The Graduate School
University College London
Gower Street London WC1E 6BT

Professor Leslie C Aiello
Head of the Graduate School

Tel: 020 7679 7844
Fax: 020 7679 7043
Email: gradschoolhead@ucl.ac.uk

13 May 2005

Dr Graham Pickup
Sub-department of Clinical Health Psychology
4th Floor
1-19 Torrington Place
UCL

Dear Dr Pickup

Re: Notification of Ethical Approval

: Schizotypy, theory of mind and the understanding of irony

The above research has been given ethical approval following review by the Chair of the UCL Committee for the Ethics of non-NHS Human Research for the duration of the project subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form'.

The form identified can be accessed by logging on to the ethics website homepage: <http://www.grad.ucl.ac.uk/ethics/> and clicking on the button marked 'Key Responsibilities of the Researcher Following Approval'.

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

Reporting Non-Serious Adverse Events.

For non-serious adverse events you will need to inform Ms Helen Dougal, Ethics Committee Administrator (h.dougal@ucl.ac.uk), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.